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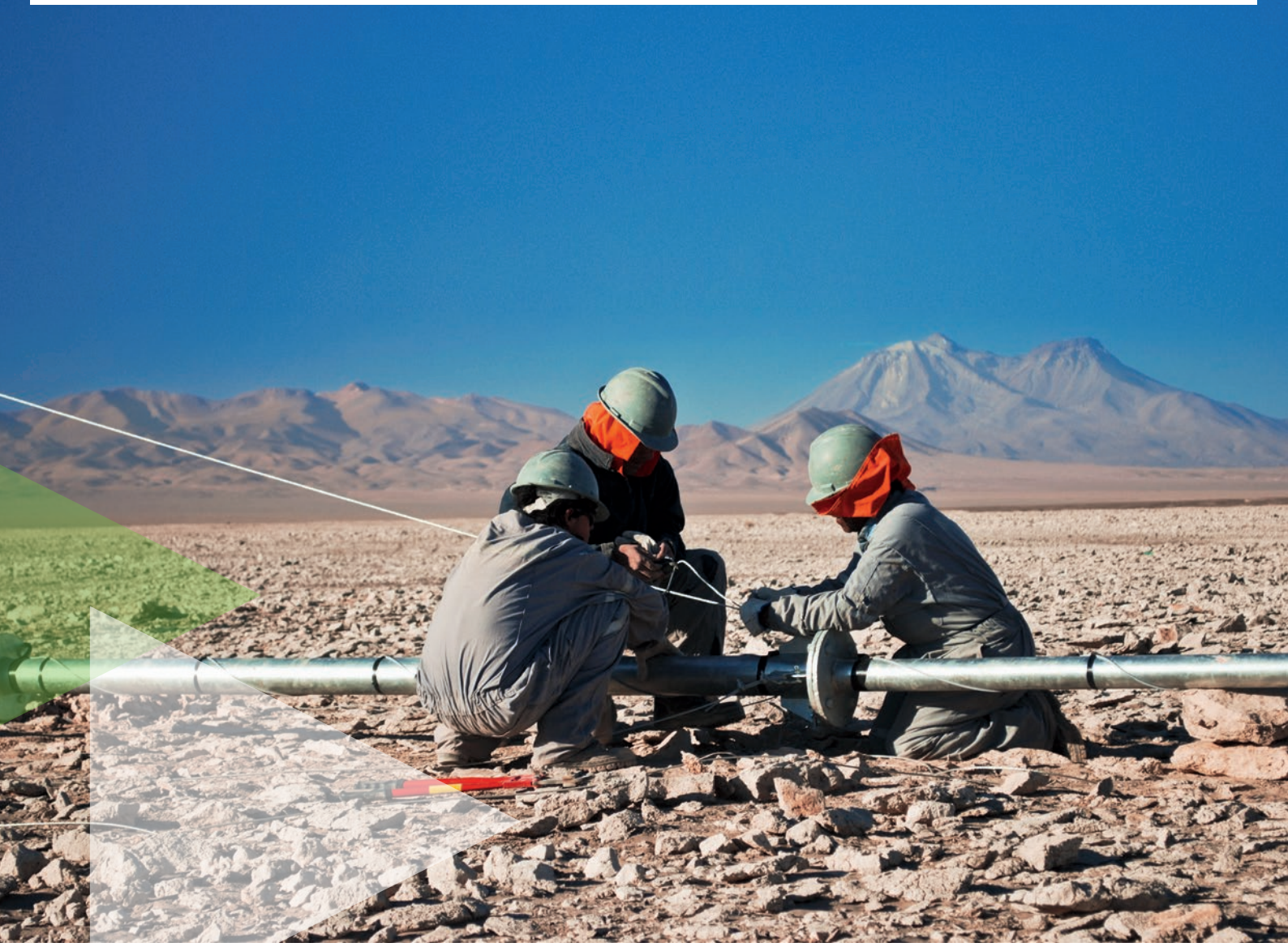

Promoting Eco-Innovation

Challenges and potential solutions for private sector development

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Abbreviations

AT	Appropriate technology
BDS	Business development services
BMBF	German Federal Ministry of Education and Research
BMWi	German Federal Ministry of Economics and Technology
BMZ	German Federal Ministry for Economic Cooperation and Development
BPW	Berlin-Brandenburg Business Plan Competition
CEFE	Competency-based Economies through Formation of Enterprise
CSR	Corporate social responsibility
DAAD	German Academic Exchange Service
GATE	German Appropriate Technology Exchange
GDP	Gross domestic product
GERD	Gross expenditure on research and development
GGND	Global Green New Deal
GHG	Greenhouse gases
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
ICT	Information and communication technology
ILO	International Labour Organization
KfW	Kreditanstalt für Wiederaufbau / German Development Bank
MSME	Micro, small and medium-sized enterprise
NGO	Non-governmental Organization
OECD	Organisation for Economic Co-operation and Development
PREMA	Profitable Environmental Management
PTB	Physikalisch-Technische Bundesanstalt / German metrology institute
PV	Photovoltaics
R & D	Research and development
SCAF	Seed Capital Assistance Facility
SEDA	Solar Energy Development Association
SIDBI	Small Industries Development Bank of India
SME	Small and medium-sized enterprise
STI	Science, technology and innovation
UNCTAD	United Nations Conference on Trade and Development
UNEP	United Nations Environmental Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization

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Eco-Innovation is an integral part of the successful transformation towards a green economy.

A well with a windpump used by nomads, Tunisia

Summary

Eco-Innovation is an integral part of the successful transformation towards a green economy. There is a need to develop incremental and groundbreaking innovations in terms of products, processes, business models and utilisation systems, while existing technologies must be rapidly scaled up and widely disseminated. However, Eco-Innovations suffer from a twofold market failure and significant government intervention is needed to overcome these barriers. At the same time, policy-makers must be aware of the trade-offs, costs and risks typically involved in these kinds of industrial and innovation policy.

In view of the urgency of the environmental challenges, emerging and developing countries need to build their capacities for researching, inventing, adapting or adopting new technologies. They also need to establish the necessary demand to help such innovations develop and prosper. Doing so is prudent, not only from an environmental, but also from a business point of view. In the course of a possible sixth Kondratieff cycle, moving quickly into new environmental technologies would allow countries and enterprises to reap first-mover advantages. While it is clear that Eco-Innovations present the private sector with significant business opportunities, these are currently still difficult to gauge in broad terms. The cross-sectoral nature of the innovations causes confusion, as does the fact that the multiple direct and indirect, positive and negative effects of the structural changes occur simultaneously.

Given the technological capacities that currently exist in many developing countries, it is likely that the greatest short-term employment effects of Eco-Innovations will be achieved through the creation of manufacturing sites, including the development of a supplier sector for relatively mature technologies. The focus would be on jobs in construction, installation and maintenance. A further short-term impact can be expected from increasing the resource efficiency of small and medium-sized enterprises (SMEs), which would encourage greater competitiveness.

In many developing countries innovation systems are nascent and remain underdeveloped. This is demonstrated using indicators such as R & D expenditure or patenting. Development cooperation for the promotion of the private sector can stimulate and support Eco-Innovation, if the partners adapt their approach to the development of innovation systems to the requirements of a green economy – i.e. how they strengthen the main pillars of the innovation system, build bridges between the relevant actors and improve the framework conditions. Any support should start with an analysis of possible entry points on both the supply side (pockets of scientific excellence in research institutions, among immigrants or in the relevant diaspora, university graduates, etc.) and the demand side (government regulations, environmental standards and labels, new consumer habits among an emerging middle class, civil society movements, demand for adherence to standards in global value chains, etc.).

A large array of tools already exists. These include competitions and incubators for green products, training courses for would-be green entrepreneurs, environmental management services for existing companies, and the Climate Protection Fellowship for academics with high potential. The need to bundle these interventions effectively poses a significant challenge. It is likewise important to improve the governance capacities of partner countries for the design, implementation and monitoring of well-coordinated policies for Eco-Innovation.

This paper begins with an exploration, in Chapter 1, of how Eco-Innovation is addressed in the current international debate. This refers mainly to the climate change negotiations and the recent Rio+20 conference. Chapter 2 then provides a working definition of Eco-Innovation and examines how it fits with the requirements of private sector development. Chapter 3 contains an overview of the general conditions under which Eco-Innovations are generated in developing countries, including both the supply side and the demand side. Chapter 4 discusses possible approaches in the context of German development cooperation, and asks which instruments can be used to foster new innovations and encourage their rapid dissemination. This chapter is structured according to the general model of innovation system promotion, as agreed upon by the Working Group on Promoting Innovation Systems[1].

1 The Working Group on Promoting Innovation Systems (Arbeitskreis Innovationssystemförderung) was founded in 2008. It consists of German implementing agencies that work in the area of innovation system promotion, namely DAAD, DIE/GDI, GIZ, KfW, and PTB.

An increasing number of researchers as well as global players now suggest that the global economy is on the eve of a far-reaching structural readjustment.

Testing chestnut oil to be used in the cosmetics industry, Brazil

1. Introduction and background

The last few years have seen an explosion in the number of concept and programme papers, conferences, workshops and development interventions that address the question of how to shape future economic and social development, while respecting our planet's capacity to sustain that development. One influential paper in this respect was the 'Global Green New Deal' policy brief, which was commissioned by the United Nations Environmental Programme (UNEP) in the context of the global economic crisis of 2008 and published in 2009[2].

The underlying idea of the Global Green New Deal (GGND) was that public money spent on stabilising and reinvigorating national economies should be invested in sectors and projects that help shape the foundations of a future green economy. This was compared to Roosevelt's New Deal for the USA, which not only helped to overcome the Great Depression of the 1930s, but also shaped US infrastructure (roads, dams etc.) for decades to come. Innovation was not an important part of the GGND concept. The expected economic stimulus would be derived in a rather short period, from large investments, for example in public transport systems, improved irrigation schemes and renewable energy projects. This would primarily involve the use of proven technologies and working with strong companies that were experienced enough to execute large-scale investment projects swiftly[3]. Ultimately, however, the GGND and related discussions were useful in guiding further research into the links between economically meaningful measures and efforts to address pressing environmental challenges.

Eco-Innovations as the basis for a future, long economic cycle?

An increasing number of researchers as well as global players like the Allianz[4] now suggest that the global economy is on the eve of a far-reaching structural readjustment. Ecological or 'decoupling' (see Box 1) innovations (Eco-Innovations) would be the drivers of this new wave of industrialisation, just as the steam engine, the railway, the automobile or, more recently, information and communication technology (ICT) drove earlier long business cycles[5]. The analogy with previous transitions between long cycles might imply 1) that a new growth and expansion cycle will follow the current world economic downturn, and 2) that the geographical focus of global

BOX 1

The concept of "decoupling" as a normative guide to Eco-Innovation

The concept of "decoupling" reflects how economic, social and environmental researchers try to deal with the trade-off between on the one hand the need for sustained high economic growth, required for poverty alleviation and improved material welfare, and on the other hand the need to protect the global environment and resource base from further depletion. Decoupling does then imply making developments possible, which assure increasing welfare, while reducing the ecological footprint of economic growth. The Organisation for Economic Co-operation and Development (OECD) defines decoupling as "breaking the link between "environmental bads" and "economic goods."

Decoupling occurs when the growth rate of an environmental pressure is less than that of its driving economic force (e. g. measured in gross domestic product (GDP)) over a given period. Decoupling can be either absolute or relative. Absolute decoupling occurs when the environmentally relevant variable is stable or decreasing, while the driving economic force is growing. Relative decoupling occurs when the growth rate of the environmentally relevant variable is positive, but less than the growth rate of the economic variable *(OECD 2002)*.

Application of technological knowledge and innovation is one of the strategic options, discussed for making decoupling feasible *(Stamm et al. 2009, p. 16)*.

2 For the short version see UNEP (2009).

3 In fact, very little of the money spent for economic stabilisation and stimulation actually was earmarked for "green" projects, with the exception of South Korea, that dedicated around 80% for projects that might help greening the Korean economy *(World Bank 2012, p. 157)*.

4 https://www.allianz.com/v_1339501901000/media/press/document/kondratieff_en.pdf

5 This concept of long waves, as opposed to short term business cycles is most often associated with the Russian economist Nikolai Kondratiev (1892 – 1938) and, thus labeled as "Kondratiev cycles".

economic power will shift away from the former and current powerhouses of North America, Europe and Japan to other world regions, most probably to Korea (which has already caught up over the last two cycles) and emerging countries, such as China, India, Brazil or South Africa.

Other new players might enter the arena, as the knowledge base in many fields is still in a state of flux, which means the entry barriers for newcomers are relatively low. To mention just one example, wave energy has nearly unlimited potential for generating electricity with zero carbon emissions. However, the technical problems are just as numerous as the devices that have been tested to overcome them. No country or large power company would yet claim to have achieved the technological breakthrough or to be the most likely candidate to dominate this market segment in the future. Instead, about 100 small companies around the world are working to find a means of converting the power of the oceans into electricity (Galbraith 2008). While this suggests there may yet be some reshuffling of the relative economic strengths in terms of these future technologies, they are most likely to include just a limited number of OECD countries plus some of the more rapidly developing countries, such as Brazil, China, India or South Africa, in which the conditions are relatively well established for developing advanced technologies and related engineering solutions.

Policy-making for Eco-Innovation, at the interface between economic promotion and environmental protection

Compared to the earlier long economic cycles, today the time factor plays a far more significant role. The urgent need to develop environmental technologies and to distribute them widely does not arise primarily from the economic function of the Eco-Innovations. Instead, it is driven by the need to address global challenges effectively, and to secure the natural conditions for the survival of future generations. Previous long cycles took at least four or five decades to develop, from the initial scientific discovery or invention (steam engine, automobile) and the maturation of new products, through to their broad dissemination and the displacement of the previously dominant technologies *(Ömer-Rieder/Tötzer 2004, p. 36)*. However, the scientific evidence now makes it very clear that, this time, waiting so long is not an acceptable option.

If the global challenges are to be addressed in a timely manner, scientific and technological breakthroughs and their large-scale dissemination must be achieved in an unprecedentedly short period of time, in many fields, such as renewable energies. This would require highly significant interventions at policy level. Moreover, in many fields the introduction of a new technology requires the adaptation of the broader socio-technical systems and societal practices (e. g. mobility patterns), which would also need to be reflected in the relevant policy-making.

The design of policies in the field of Eco-Innovation must also address the fact that measures to ensure environmental sustainability (such as carbon pricing or other ways of internalising the environmental costs of production and consumption) can involve benefits and costs being distributed unequally among individuals and groups, with some clear winners and losers. Therefore, at its core, Eco-Innovation policy-making is not only a technical but a very political issue. An added complication is that these interventions take place in sectors which harbour considerable business potential for the future. Consequently, there is a high risk of political capture, and economic stakeholders also have substantial interests to consider.

Eco-Innovation in the international policy discourse

Technology transfer and the strengthening of local innovation capacities in developing countries have long been included as topics of international negotiations. Since the 1960s, this has been driven by the G77 countries through forums such as the United Nations Conference on Trade and Development (UNCTAD). The debate has gained impetus in the context of efforts to achieve sustainable development around the world, while avoiding dangerous global warming. For instance, the 2007 United Nations Framework Convention on Climate Change (UNFCCC) Bali Plan of Action explicitly raises the need to foster international technology transfers and promote research cooperation in climate-related disciplines.

In advance of the Rio+20 conference in 2012, developing countries made sure the role of science, technology and innovation (STI) for environmentally sustainable development was high up on the political agenda, by making a series of specific proposals and political demands *(ICTSD 2012)*:

- Technology transfer for sustainable development, improving access to environmentally sound technologies (G77 and China); new and innovative mechanisms to finance the transfer of such technology (Argentina); a repository of ideas and tried-and-tested initiatives (Brazil); the establishment of regional centres specialising in the transfer of technology to promote the transition to a green economy (Mexico).

- International financial arrangements to help induce the necessary drop in global prices for these technologies, to make them universally affordable within one or two decades; globally funded guarantees or price supports, e. g. through a global programme of 'feed-in tariffs' (Pakistan).

- Support for the further development of technologies through research, including the expansion of scientific, technological, professional and related capacities, and the provision of incentives for innovators (G77 and China); a mechanism to facilitate research and development (R & D) for green technologies in the public domain (India).

The statements made by industrialised countries and groups (Japan, USA, EU) in the run-up to Rio+20 remained rather vague. They stressed the common responsibility of the governments of both developing and developed countries for shaping incentive systems for innovation, and for open and competitive markets, investment in education, workforce and basic research, the protection of intellectual property rights, etc. Their commitments to the developing world mainly refer to the sharing of past experiences and the development of appropriate international networks *(ICTSD 2012)*.

'The Future we Want', the document of outcomes released by the Rio+20 conference, mentions STI in a few general and sector-specific paragraphs. It then dedicates an entire section (section B) of its chapter 'Means of Implementation' to the subject of technology. Another section (section C) is devoted to capacity building. *(UN 2012, p. 51 – 53)*. Thus, the document from the more recent conference gives technology a more prominent position than it was given in the 'Plan of Implementation of the World Summit on Sustainable Development', published by the earlier Rio+10 summit, in Johannesburg in 2002. However, this is not accompanied by any more decisive actions or commitments on the part of the industrialised world, which would significantly advance technology transfer, research cooperation or capacity building beyond what was already included in earlier documents that have had only a marginal impact on global policy-making.

The outcome of the Rio+20 conference was disappointing for many, both in general terms and with regard to STI. It seems rather unlikely that it will mark the beginning of a paradigm shift in international cooperation for a sustainable future. Nevertheless, the renewed interest in the topic of STI for development can be expected to prompt new demand for financial and technical cooperation. This would include policy advice for the setting up of sustainability-oriented innovation systems *(SOIS, see Stamm et al. 2009)* as well as the provision of new and targeted training courses, the creation of programmes for establishing and developing links between publicly funded research organisations and private companies, and the establishment of business incubators for green enterprises. This paper explores the instruments of German development cooperation that would be best suited for reacting to this demand.

Eco-Innovations address non-existent or very underdeveloped markets and require a significant level of government intervention.

Thermal renovation of a school, Mongolia

2. Eco-Innovations – a working definition and their relevance for private sector development

In recent years, the OECD has developed its Green Growth Strategy, comprising some important conceptual components of green innovation *(OECD 2010c, 2011a, 2011b, 2011c).* Other international organisations, such as UNCTAD or the United Nations Industrial Development Organization (UNIDO), have developed policy papers dealing with green growth or the greening of industry, without explicitly dealing with green innovations. The World Bank recently launched a paper exploring the relationship between green growth, technology and innovation *(Dutz/Sharma 2012).*

The OECD stresses that no strong and widely shared definition of Eco-Innovation has as yet been developed: ***"An inventory of Eco-Innovation policies in OECD countries unveils a variety of definitions across countries (and sometimes across authorities in a single country)."*** *(OECD 2011a, p. 29)*. So any approach to Eco-Innovation must first draw on the clear understanding of the term innovation, for which a widely shared consensus does exist. The OECD's Oslo Manual defines it thus:

> *An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations.* *(OECD 2006)*[6]

Eco-Innovations can then be further identified by their favourable impact on the environment, or the promotion of climate change mitigation or adaptation. However, this is not straightforward. For instance, an environmentally friendly product may result in rebound effects (see Box 2) and thus create or worsen an environmental problem instead of mitigating or solving it.

6 This definition is directly derived from the seminal work by the Austrian economist J. Schumpeter (1883 – 1950).

BOX 2

Adding to the complexity of dealing with Eco-Innovation: the 'rebound effect'

At first sight, any technology that enables the production of the same amount of goods or services for a lower input of (fossil) energy and other non-renewable resources must have a positive environmental effect. However, this is only true if the benefits from the new technology are not cancelled out or even exceeded by changing patterns of consumption among households and enterprises. This correlation, known as Jevons' Paradox, was first discussed in the second half of the 19th century. The British economist Jevons observed that the introduction of coal-saving technologies in steam engines did not reduce the consumption of coal. Instead it increased demand, as the greater energy efficiency led to the much wider use of steam engines around the country.

In terms of the current debate on the transition to green growth, potential rebound effects are most often seen in environmentally deleterious consumption triggered by technological innovations *(Sorrell/Dimitropoulos 2008).* For instance, more fuel-efficient cars may encourage individuals to drive more, rather than switching to public transport; or hybrid and electric cars might become fancy accessories, while house-holds still satisfy the bulk of their transport needs with cars that use fossil fuel. 'Environmentally friendly' cars could also lower the psychological incentives to look for alternatives, and end up serving as an excuse *(Fichter et al. 2006, p. 34).*

In this paper, we deliberately use the term Eco-Innovation rather than sustainability innovation, as this implies a focus on innovations that enhance the environmental performance of products, processes and growth patterns. The social dimension of Eco-Innovation base development is left out of the analysis, simply to reduce its complexity.

2.1 Definition of Eco-Innovation

The body of recent literature that is most relevant to Eco-Innovations, and which incorporates international experiences, consists of the OECD Innovation Strategy *(OECD 2010c)*, the OECD Green Growth Strategy *(OECD 2011e)* and related documents on climate and Eco-Innovations *(OECD 2010a, 2010b, 2011a, 2011b, 2011c, 2011d)*. However, these are still mainly related to industrialised countries. OECD *(2011a, p. 29)* refers to a paper of the European Commission, defining Eco-Innovations „as all forms of innovation that reduce environmental impacts and/or optimise the use of resources throughout the lifecycle of related activities." The following statements can be made based on this paper.

- Eco-Innovations compare favourably with relevant alternatives, in terms of their impact on the natural environment.
- They apply to goods, services, manufacturing processes or business models.[7]
- In the case of product innovations, the whole life cycle has to be considered, from a product's inception and usage up to its recycling and/or final disposal.
- In the case of process innovation, changes in industrial production or service delivery optimise the use of resources without causing adverse environmental impacts that could negate their positive environmental effects.
- Eco-Innovations include, but are not limited to, green technologies. They do not necessarily originate in the environmental field or have a technological component.
- Eco-Innovations can be radical and systemic (e. g. substituting polluting goods with environmentally-friendly alternatives), or incremental (e. g. enhancing the resource efficiency of a particular product).

Some of the categories used for conventional, commercial innovations can also be applied to Eco-Innovations, as follows.

- Product and process innovation: technological knowledge can be used to introduce a new item into society and/or the market. If a more ecologically efficient product replaces a less ecologically efficient one, this can be called an 'ecological product innovation'. If technological progress makes industrial processes more resource-efficient and/or less pollution-intensive, this can be called an 'ecological process innovation'.
- Incremental, disruptive and radical innovation *(OECD 2011b, p. 19f)*: Incremental innovations are upgrades to existing technologies, producing innovation within existing technological regimes, such as increases in the speed of microprocessors. Disruptive innovations are new methods of performing existing technical functions, changing how things are done but not changing the overall regime. An example would be the shift from film to digital imaging. Radical innovations are technological regime shifts, involving wholly new technical functions, new knowledge bases and new organisational forms, such as the transition from steam power to electricity. *(Smith 2009, p. 17 – 21)*
- New to the world, new to the market and new to the firm: An innovation is new to the world if the firm has introduced a new or significantly improved good or service to the global market, before its competitors. It is new to the market or industry if the firm is the first in that specific market or industry to have implemented it. It is new to the firm if the innovation was already available from its competitors in its market *(Plechero/ Chaminade 2010, p. 4)*.

7 In the United States, the concept includes innovative regulatory approaches to environmental protection as well.

When comparing Eco-Innovations and conventional innovations, the main difference is that Eco-Innovations suffer from a twofold market failure:

1. Eco-Innovations experience the general market failure of any innovation, which is that entrepreneurs and companies cannot be sure, whether and to what extent they will recover their STI-related expenditure by securing a larger market share and/or higher profit margins. This is because newly created knowledge tends to leak out to competitors rather quickly, a process that cannot ultimately be contained by using patents or copyrights *(see e.g. Mansfield 1985)*. This non-appropriability of innovation-related investments is one of the conventional arguments for public spending on R&D – the further away from market rollout the STI investment happens, the further the public share of the resources will usually be, as the positive externalities will usually be larger.

2. In the case of Eco-Innovations, the conventional aspect of market failure through positive knowledge externalities is further aggravated by non-internalised, negative environmental externalities of conventional modes of production, such as greenhouse gas emissions, water pollution, unsustainable logging and solid waste disposal. Even in Europe, where most governments and societal stakeholders are committed to the transition to sustainability, and where the institutions responsible for regulating and enforcing environmental standards are relatively strong, the attempt at internalising negative environmental externalities with an emissions trading scheme (ETS) has encountered severe problems in its implementation *(Skjærseth/Wettestad 2008)*. In many developing countries, regulations are only just being introduced to control gaseous and liquid emissions or the disposal of solid waste, and their enforcement has yet to become established. Crucial inputs to traditional production and service provision are often heavily subsidised (fossil fuels); and in some cases, the cost of resources is too low to encourage their careful utilisation, as is the case, for instance, with the timber supply in areas of high deforestation.

Eco-Innovations therefore address non-existent or very underdeveloped markets and require a significant level of government intervention. As in other areas of industrial policy and private sector promotion, government intervention must be approached with caution, so as not to provoke excessive price distortions or to risk being influenced by the particular interests of individuals or stakeholder groups. The latter risk is particularly high because, despite their current state of under-development, many Eco-Innovations are seen as huge potential markets of the future. Even well targeted government interventions, such as feed-in tariffs for renewable energies or regulations to improve the efficiency of household lighting and appliances, usually come at a cost to the consumer or the producer – and in many cases producers will pass on their costs to the consumers.

Public authorities, environmental non-governmental organizations (NGOs), media and/or other stakeholders must therefore work to achieve and maintain legitimacy for deep interventions in support of Eco-Innovations. Moreover, where the promotion of Eco-Innovations causes significant price rises for basic services, such as energy, water and sanitation, it may become necessary to compensate poorer societal groups, which introduces an additional field of complex governance issues.

We can therefore appraise the complexity of government interventions to promote Eco-Innovations that are intended to have a real impact on the environmental sustainability of economic growth and the aggregated social consumption of goods and services. An additional governance challenge is the fact that special weight must be given to the dissemination phase. Eco-Innovations often need to be deployed on a wide scale and as fast as possible, for reasons that are separate from the economic process. Only their broad-based roll-out can lower the environmental pressures exerted by economic and social activities.

BOX 3

Lessons learnt from the promotion of appropriate technologies through German development cooperation

In the introduction to his Appropriate Technologies in a Globalizing World, Atkinson *(2004, p. 3)* asks why more than three decades of dealing with appropriate technologies (ATs) – including discussions, specific co-operation projects and institution building – has not brought some significant results; why, as he puts it, ATs 'seem to have withered on the vine'.

The concept of ATs can be linked to the work of the German-British economist Fritz Schumacher and his book Small Is Beautiful *(1973; German edition 1977: Die Rückkehr zum menschlichen Maß)*. The various concepts used between the 1960s and the 1980s to characterise ATs as an alternative to conventional technologies demonstrate the politicised character of the debate. ATs (community technology, village technology, liberatory technology etc.) were seen as an alternative to the mainstream concept of transferring technology from the industrialised to the developing countries. Important intellectuals from developing nations, such as Mahatma Ghandi and Celso Furtado (Brazil), advanced the idea of ATs or intermediate technologies as means of strengthening the independence of developing countries and aligning industrial-economic developments to the needs of poor nations.

In Germany, for an exceptionally long period of around 30 years (1978 – 2007), the German Appropriate Technology Exchange (GATE) programme was mainly responsible for promoting ATs in agriculture, post-harvest processing, agribusiness, industry and basic services (electricity, cooking, housing). GATE defined appropriate technologies as, 'solutions which are particularly suitable, from both the macro-economic and the microeconomic points of view, and which accord with the given social and cultural structure'. GATE's activities comprised technology exchange, R & D, and industrial cooperation.

Possible reasons why these efforts have not been as succesful as hoped for the effective deployment of ATs can be found on different systemic levels:

- Many ATs cost more than conventional technologies, often because the price of the latter does not reflect their negative environmental effects and/or because they benefit from state subsidies (for instance on fossil fuels).
- Many ATs were introduced by NGOs. While these possess considerable expertise for social development, they are often less strong in aspects of business administration.
- ATs were often implemented in projects that were insulated to some extent from harsh commercial realities. The transition from 'protected projects' to the reality of the marketplace was often poorly prepared and supported.
- In many cases, the focus was on specific technologies and individual actors. This neglected to include the innovation processes that enable companies to adjust to changing conditions and the systemic interaction of the different actors in the system.

Sources: Atkinson (2004), and personal communication with Dr C. Hellpap (GIZ), all responsibility for errors and misjudgement remains with the author.

Already today, urgency arises from the fact that environmental pollution causes severe distress and poses considerable risks to large population groups. For instance, indoor air pollution from inadequate cooking and lighting methods is known to be responsible for many cases of severe illness and even death, especially among the women and children of poor households in developing countries. Similar impacts are observed in the use of contaminated water or the spread of infectious diseases through the inappropriate handling of solid waste, etc. In such cases, the need to deploy new products, processes, methods and services as fast as possible derives from the ethical imperative of averting human suffering.

In other cases – often on a larger geographical scale – the urgent need to implement Eco-Innovations as quickly and as widely as possible is in response to risks posed by the intensification of processes that could prompt the rapid deterioration or even collapse of important parts of the geosphere and/or biosphere. Currently, of course, the most important example is global warming induced by the emission of CO_2 and other greenhouse gases (GHG). Rising average temperatures are causing parts of the arctic ice shelf to melt, which is in turn reducing the albedo[8] of large areas of the earth's surface, thereby contributing to further global warming. Determined human action is needed in order to break this vicious cycle before a point of no return is reached. All the available scientific evidence indicates that this will require significant changes in production and consumption patterns, with a concomitant reduction in our environmental impacts, in a very short timeframe.

Finally, urgent action is sometimes needed to avoid instigating unsustainable technological regimes in certain sectors and/or regions – especially when, due to economies of scale or positive feedback loops between several elements of the system, these might be difficult to modify or rescind. Researchers into innovation systems talk about path dependency and lock-in effects. One example of this might be the provision of electricity to rural populations, or remote hospitals and schools which have not yet been connected to a national or regional grid that is fuelled by fossil energy sources. With regard to environmental sustainability, offering a high quality electricity supply based on innovative renewable energy technologies (mini-grids, second generation biofuels) would definitely be better. However, this would very often require extensive secondary measures, such as establishing relevant institutions and setting up training courses and other capacity building activities. Once the target population is in reach of the larger grid, such measures might be ruled out as being too expensive when compared with the opportunity costs of going the 'last mile' in the traditional system.

An important example of how the swift introduction of technical solutions, combined with clear and determined international regulation, can have a significant positive impact on the environment was the substitution of ozone-depleting gases (above all chlorofluorocarbons – CFCs) following the negotiation and ratification of the Montreal Protocol on Substances that Deplete the Ozone Layer in 1987/1988. The Montreal Protocol is considered one of the good examples of effective collective action to address a global challenge *(Royal Society 2011, p. 73f and Bauer 2009)*. Nevertheless, research has shown that the severely damaged ozone layer will only recover by around 2050. This suggests that significant time-lags should be expected between the taking of determined action and any positive outcomes on the ground. In other words, in a field such as climate change determined action has to be taken within the next few years in order to ensure the stabilisation of global ecosystems in the long run.

8 Albedo is an indicator of surface reflectivity measured as the ratio of reflected radiation to the initial incident radiation. White surfaces tend to reflect a much higher percentage of solar radiation.

Urgency therefore arises either from the social norm of wanting to avoid distress and risks to large population groups, or from a need to avoid exceeding tipping points in (global) ecosystems (climate, biodiversity, fish stocks). While considering the urgent time pressure for actions to avoid further deterioration in global ecosystems, the **'imperative of responsibility'** *(Hans Jonas, 1985)* should not be ignored.[9] Solutions have to be found that address environmental problems without creating additional risks to ecosystems and societies, such as, for instance, eroding global biodiversity and food security through the large-scale production of biofuels for energy generation and transport. Technological solutions might have to be implemented before they can be thoroughly tested for undesirable side effects (carbon capture and storage, geothermal energy). As a result, in the relevant policy arenas there will be a special need for permanent monitoring and the capacity to fine tune initiatives.

2.2
Relevance for economic policy advice and private sector development: Eco-Innovation and employment creation

For many developing countries, deciding whether or not to invest considerable financial resources and governance capacities in the promotion of Eco-Innovations depends to a large extent on the benefits those investments are expected to bring – less in terms of global, regional or local ecosystems, than the potential benefits for economic growth, job creation and job security, and poverty reduction.[10]

The link between Eco-Innovations and their related regulations and policies, and the expected business and employment effects is certainly not limited to the developing countries. Most policy-makers in advanced industrialised countries are also motivated much more by short-term considerations of how to strengthen the economy and boost employment, than long-term ideas about preserving the global environment. In most of the countries affected by the current economic and financial crisis, environmental issues seem largely to have disappeared from the political agenda. In Germany, faced with rising energy prices resulting from energy taxes and feed-in tariffs for renewable energy, employers' organisations have warned that some industries might lose their international competitiveness if that trend continues. In fact, many companies that are especially energy-intensive are exempt from politically set surcharges.

9 In his famous Imperative of Responsibility (first published in German in 1979) Hans Jonas (1985) promotes prospective moral responsibility as a response to the challenges of modern technology. He defines responsibility as a non-reciprocal duty to care for beings, including humans, other animals and future generations.

10 That is not to say that developing countries' governments might not be willing or able to take global ecological challenges into consideration when developing their strategies, but they usually face huge pressure to prioritise the pressing social problems of their constituency.

Exploring the way changes in environmental regulations and policies will affect employment levels is not at all easy, as empirical evidence is rather scanty, the cause-and-effect chains not completely understood, and some forces might function in opposite directions. Things are further complicated by the fact that Eco-Innovations are not confined to a single specific sector of the economy, for which at least the formal employment figures are usually captured (more or less well) in national and international statistics.

Table 1: Initial estimation of the impact of Eco-Innovations on labour markets

Type of effect	Observation
Positive employment effects	a) Green jobs in R & D and manufacturing of new technologies/industries (wind turbines, solar PV, biofuels, etc.). b) Job creation in supplier companies to the manufacturing industry. c) Jobs in the project implementation and construction industry; infrastructure for a green economy, erection of wind turbines and CSP plants, etc. d) Job creation in distribution, maintenance and repair; possibly installation of innovative green products. e) Investment in process innovations that bring cost savings in terms of materials and energy, and contribute to the competitiveness of an industry, thus preserving existing jobs.
Possible negative job effects	f) Environmental regulations can have adverse consequences for jobs, by raising costs, reducing demand or rendering a factory or company uncompetitive. g) Higher levels of environmental protection on the lead markets may establish new non-tariff barriers to trade.

Source: Author's elaboration, partially based on UNEP (2008, p. 44)

In 2008, the UNEP published a report as part of the joint Green Jobs Initiative of UNEP, the International Labour Organisation (ILO), the International Organisation of Employers (IOE), and the International Trade Union Confederation (ITUC). The report *(UNEP 2008)* examined the effects on labour markets around the world of the 'greening of economies'. Its definition of 'green jobs' reveals the complexity of the cross-sectoral effort to reduce the ecological footprint of economic activities:

> *We define green jobs as positions in agriculture, manufacturing, construction, installation, and maintenance, as well as scientific and technical, administrative, and service-related activities, that contribute substantially to preserving or restoring environmental quality.*
>
> *(UNEP 2008, p. 36f)*

Table 1 outlines different ways in which the greening of the economy (mainly through Eco-Innovation) might affect the labour market. Applying these impacts to the typical profile of a developing country it would seem appropriate to limit our expectations regarding the possible employment effects of Eco-Innovations, at least in the short term.

Table 2: Green employment in OECD countries

Country	Green employment (total and/or % of workforce)	Projections
Australia	No data	230,000 – 340,000 jobs over the next 10 years
Austria	163,000 *(2008)*	No data
Belgium	No data	Small effects, potentially positive
Canada	640,000 – 4% *(2006)*	No data
Finland	5,888 workers in firms with mainly green activities	Positive employment effects in forestry, construction, energy; negative effects in industry
France	1.6% *(2010)*	200,000 new jobs 2007 – 2012
Germany	4.5% *(2006)*	No data
Greece	No data	210,000 new jobs, whereof 29,000 permanent
Hungary	No data	200,000 new jobs by 2020
Korea	604,000 – 2.6% *(2008)*	Green New Deal to create 960,000 jobs 2009 – 2012
Norway	No data	+ 0.5% – 1.5% by 2020
Portugal	0.4% *(2008)*	120,000 new jobs in the energy sector, mostly renewable
Spain	531,000 – 2.6% *(2009)*	1 million jobs by 2020

Source: OECD (2012, p. 120f)

The core technologies used in Eco-Innovations are still mainly being developed in the traditional 'triad' of industrial powerhouses (Japan, USA, Europe). This is evident, for example, in the number of patent applications for climate mitigation technologies *(OECD 2011e, p. 52, see figure 1)*. With the exception of China (which is seventh in the global ranking of the relevant data from the OECD patent database) and perhaps India (ranked 19th, between Austria and Norway), no developing or emerging country is yet contributing to the research and product development phases of important Eco-Innovations, at least as reflected in patent statistics.

Many Eco-Innovations are being developed, and the related products manufactured in the older industrialised countries, some newly industrialised countries (mainly South Korea) and a limited number of rapidly emerging anchor countries, such as China and India (wind turbines, solar photovoltaic (PV)). For most developing countries, therefore, the main prospects for using Eco-Innovations for the large-scale creation of jobs would seem to lie in the following areas.

- Establishing R & D laboratories and manufacturing sites (see Table 1, observation a); perhaps – in countries that have already developed significant production capacities and can compete internationally in terms of qualified labour costs – the creation of a supplier base for relatively mature technologies (see Table 1, b). For the example of wind power and CSP in Egypt, see *Vidican 2012*.

- Project implementation, construction, installation and maintenance jobs (see Table 1, c) that are relatively easy to localise and where suppliers have their own motivation to provide technical assistance and may therefore become partners of national stakeholders in capacity building and employment creation.

- An important driver of jobs might still be the core activities of Eco-Innovation generation, such as distribution, maintenance and repair, and installation where required (see Table 1, d).

Eco-Innovations that address processes in industries can contribute to savings in materials and energy (see Table 1, e). In developed countries, the costs of materials (40%) and energy (2%) represent an important share of firms' overall costs *(Meyer/Meyer/Distelkamp 2012, p. 146)*. Under these conditions, Eco-Innovations might contribute directly to a company's competitiveness. The same benefits can also be achieved in developing countries, which is something UNEP and UNIDO have tried to encourage since 1995 with their Cleaner Production Centres:

> *Although CP (cleaner production) usually requires capital investment, it often gives monetary returns by minimising energy consumption and lowering material and handling costs. By doing this, the CP approach becomes both an environmental and a production strategy.*
> *(Ashton/Luque/Ehrenfeld 2002, p. 8)*

In many cases, cleaner production and the related Eco-Innovation strategies in developing countries seem to be triggered less by cost considerations on the part of managers or business owners than by government regulations or pressure from the lead firms in international value chains. This might be due to a lack of awareness about the cost-saving potential of Eco-Innovations, or because input prices are distorted, for instance, through the use of energy subsidies.

Business owners in developed and developing countries alike are wary that more stringent environmental regulations could lead to a competitive disadvantage, especially if their competitors from other countries are not subject to similarly strict rules. In an extreme case this can make a production site unfeasible (see Table 1, f). However, empirical evidence shows that cases of companies being ousted from a market due to environmental regulation are not common. *(UNEP 2008, p. 44)*.

Finally – and similarly – businesses often fear that environmental regulation in the larger markets might become non-tariff barriers to trade (see Table 1, f). To some extent, this is an inversion of the earlier argument about 'pollution havens' which suggested that stringent environmental regulations in the industrialised countries would lead to the relocation of 'dirty' industries to developing countries, where production could continue with no rules, or only soft rules regarding environmental externalities. The inversion would mean that if the markets of industrialised countries require adherence to very strict standards, for example, of energy efficiency or pesticide use, this could become prohibitively expensive for developing countries' products. Cole and Elliot *(2003, p. 1163f)* provide an overview of the relevant studies, and they show that there is no clear empirical evidence for either the pollution haven or the barrier-to-trade hypotheses. However, it cannot be denied that the current debate on climate-friendly consumption might trigger patterns of demand that involve a unilateral focus on transport distances and 'food miles', rather than considering the climate impact of the complete life cycle of a product.[11]

11 Life cycle analyses show, for instance, that at certain periods during the year local food products might result in a higher CO_2 impact than imported goods, as the former have to be kept under refrigeration for a long time, requiring energy consumption and greenhouse gas emissions that outweigh those of long-distance maritime transport.

Even after recording all these complex relationships, it should be noted that Table 1 does not fully capture the complexity of the trade-offs between employment creation and possible jobs losses induced by a green transformation. Many Eco-Innovations will only exhibit their full environmental benefits after they have shaped their respective sector, displacing older 'dirty' technologies. One obvious example is the use of renewable energy sources to replace fossil fuels for electricity generation. While power generation is not in itself a sector that provides many job opportunities, in countries that extract their own fossil fuels, for instance through coal mining, this is often an important source of employment and income. In such cases, a generalised energy transition could bring severe job losses in the fossil fuels sector.

An adverse impact on the labour market can also be expected, for instance, if regulations to increase energy efficiency in household appliances cause a rise in the quantity of imported goods from the technological leaders in this sector at the cost of locally produced goods with a lower efficiency. Also, the elimination of fossil fuel subsidies and other policy interventions (such as feed-in tariffs for renewable energy) could increase the costs of basic services, thereby lowering the purchasing power of large segments of the population. As such a negative multiplier effect would lead to job losses.

Under these conditions (and in the affected countries) the net employment balance of a green transformation driven by Eco-Innovation is extremely difficult to predict. In a recent study of the employment potential of a shift towards a low-carbon economy, the OECD included 'green' employment data from its member countries, although many of them did not have any useful information available. These data are summarised in Table 2. Above all, this shows, yet again, how difficult it is to quantify green employment data or to compare the figures of different countries. Still more difficult are the projections made about the labour market effects expected in the future.

Notwithstanding the methodological problems, it is evident that the green economy and green innovation are still far from being an allround job engine for OECD countries. In its recent Green Growth Report, the World Bank concludes: ***'fears that environmental regulations will lead to massive job losses or loss of competitiveness are probably as unfounded as the hope that green jobs will single-handedly solve countries' employment problems.'*** *(World Bank 2012, p. 102)*

It is evident that, in many cases, the process of asserting political ownership for pro-Eco-Innovation policies in these countries will necessitate a comprehensive development strategy for micro, small and medium-sized enterprises (MSMEs). It will be important to improve employment levels in the relevant sectors for the introduction of the new technologies, and only in a very few cases will it make sense to enter into the early stages of R & D for Eco-Innovations.

In this context it should be said that, even in Germany, which is currently the most successful country at promoting renewable energies (2011: nearly 382,000 jobs), many of the jobs created are not related to the manufacture of high technology products, but rather involve the installation of PV facilities on the roofs of private or commercial buildings, and the construction and operation of small and medium-sized biogas facilities *(O'Sullivan et al. 2012)*. The elasticity of the German labour market in the renewables sector can be linked to the generally high level of technical training enjoyed by the owners and managers of small businesses. This has enabled them, for instance, to diversify from a traditional plumbing business to the installation of solar PV modules. It also suggests that the promotion of Eco-Innovations in developing countries must include efforts to strengthen local capacities and generate 'green skills' through technical and vocational training, including programmes of occupational retraining for people currently employed in traditional sectors of the economy.

Eco-Innovations can potentially have their most direct effects in the agricultural sector, where the linkages to environmental issues are most apparent, as a large part of the economically active population in the partner countries still lives in rural areas. In agriculture and agribusiness, Eco-Innovation is particularly difficult to define, although newer farming practices that reduce soil degradation and GHG emissions from agriculture (no-till farming, organic agriculture) may be less contentious. The potential for employment creation is high, because the use of chemical inputs and machinery is often substituted by manual labour. In other cases, new technologies entail a difficult debate of the pros and cons as is seen, for example, with the new methods for producing liquid fuels from locally available oil plants.

Long-term outlook difficult to predict

Although under the prevailing conditions there is apparently only modest potential for Eco-Innovations to become a driving factor of employment in developing countries, this could change in the long run. Drawing an analogy to the ICT revolution, the OECD *(2011b, p. 55)* concludes that green innovations will only prompt the required high growth rates and related employment creation if there is a very significant decline in the prices for products and services.[12] For instance, when PV cells and panels have become a cheap and ubiquitous commodity (as is the case with cell phones today), an immense number and variety of different applications may develop, giving rise to new business opportunities for local tradesmen, SMEs and service providers. However, it would be mere speculation to try and forecast when this will happen.

12 The US producer price index for the manufacture of computers fell by about 14% annually, between January 1981 and January 2011 (OECD 2011b, p. 55).

There are islands of innovativeness, or even individual entrepreneurs with an innovative spirit – and these should be the starting point for donor interventions.

Building a wind farm in Kanyakumari, India

3. Eco-Innovations in developing countries – an introduction to the basic supply and demand factors

Relatively little evidence is currently available regarding international patterns of Eco-Innovation, on either the supply side or the demand side. As with employment generated by green activities (discussed in Chapter 2), one of the main methodological problems in this respect is that environmental products and services, including Eco-Innovations, are not confined to a specific business sector. Instead they occur as crosscutting phenomena in all major areas of economic activity. They sometimes even appear as subsidiary aspects of individual companies that offer 'green products' for specific market niches, while maintaining energy-consuming and/or pollution-intensive goods for the mainstream market.[13]

Another problem is that it is a complex undertaking to harmonise innovation indicators, especially since the related methods and established manuals, such as the OECD's Oslo Manual, largely reflect the reality of industrialised countries. Only in recent years have efforts been made to extend harmonisation to include developing countries, for instance through the two initiatives:

- Ibero-American and Inter-American Network for Science and Technology Indicators (Red de Indicadores de ciencia y tecnología – RiCyT) and its related Bogotá Manual (www.ricyt.org);
- African Science, Technology and Innovation Indicators (ASTII) initiative (www.nepadst.org/astii/index.shtml).

To the extent that they are available, we will present some of the main indicators in Chapter 3.1, combining them with more qualitative information. Assessing the demand side of Eco-Innovations is even more difficult. Chapter 3.2 summarises some findings in this respect.

13 The German car maker Porsche can be taken as an example. In 2011 Porsche launched its hybrid car, the 918 Spyder, with a very high price and in a very small production run. Meanwhile, the company's current cash cow is the Porsche Cayenne, with an average fuel consumption of between 13 and 17 litres per 100 km.

3.1 The supply side of Eco-Innovation in developing countries

Allowing for the absence of a comprehensive set of indicators covering Eco-Innovation, we begin this chapter by presenting some basic findings about general innovation capacities in an international comparison. The basic assumption is that capacities for Eco-Innovation are essentially a variation of general innovation capacities. While it cannot be assumed that all countries that are strong innovators are also good at developing Eco-Innovations, it seems very plausible that countries that are weak innovators in general will not be especially strong in the field of Eco-Innovations. In the second part of the chapter we will present some additional figures more directly related to Eco-Innovations, based on the patents for a selection of climate change and energy technologies.

General overview of innovation capacities in an international comparison

Probably the most widely used indicator of innovative capacities at the country level is the gross expenditure on research and development (GERD) in relation to the GDP – the GERD/GDP ratio. GERD can be understood as the sum of public and private sector expenditure on R & D. One of the accepted weaknesses of this indicator is that it cannot capture innovation which is not based on formal R & D investments as reported to the national statistical bureaus. To some extent this leads to an underrating of innovative capacities in sectors such as the German machine tool industry, where most innovation does not happen in dedicated R & D departments, but in the form of continuous day-to-day improvements by the manager, often in close cooperation with clients. This weakness is likely to be more pronounced when it comes to capturing private sector R & D in developing countries, where the private sector is dominated by SMEs which usually do not have a tradition of formal R & D or the related accounting.

Bearing these caveats in mind, the question of how much a society is verifiably willing to invest in R & D can still be taken as a reasonably adequate indicator for its overall innovativeness. In this respect, the difference between industrialised and developing countries is striking. Some exceptions can be identified, though these do not significantly change the general rule. The variation is larger with regard to the industrialised countries,[14] among whom the top performers (Israel, Finland, and Sweden) have a GERD/GDP ratio ranging from between 3.5% and 4%, compared to those which lag behind such as Spain (1.38%), Italy (1.27%) or Greece (0.6%).

The gap between these and the developing countries is generally very large. China has clearly done most to catch up in its per capita R & D spending, having attained a GERD/GDP ratio of around 1.5% in 2008. Only two other countries have reached or surpassed the 1.0% level (Tunisia: 1.10% and Brazil: 1.08% – both in 2008). Elsewhere, even some or the countries that perform relatively well still lag significantly behind even the poorest performers of the industrialised world (Cuba: 0.49%, Costa Rica: 0.40%, Chile: 0.39%).

With respect to the human resources dedicated to research activities, a similarly striking difference can be observed between most of the industrialised countries and most of the developing world. In the economically active population of most industrialised countries, the number of people per million engaged in research is well above 1,000 (e. g. Finland: 7,670, Germany: 3,780, France: 3,780). Among developing countries, even those that are relatively strong in research have a very small researcher population. For example, there are fewer than 700 researchers per million people in the case of Brazil, and fewer than 300 in South Africa or Chile. One exception is Tunisia, with around 1,863 researchers per million[14].

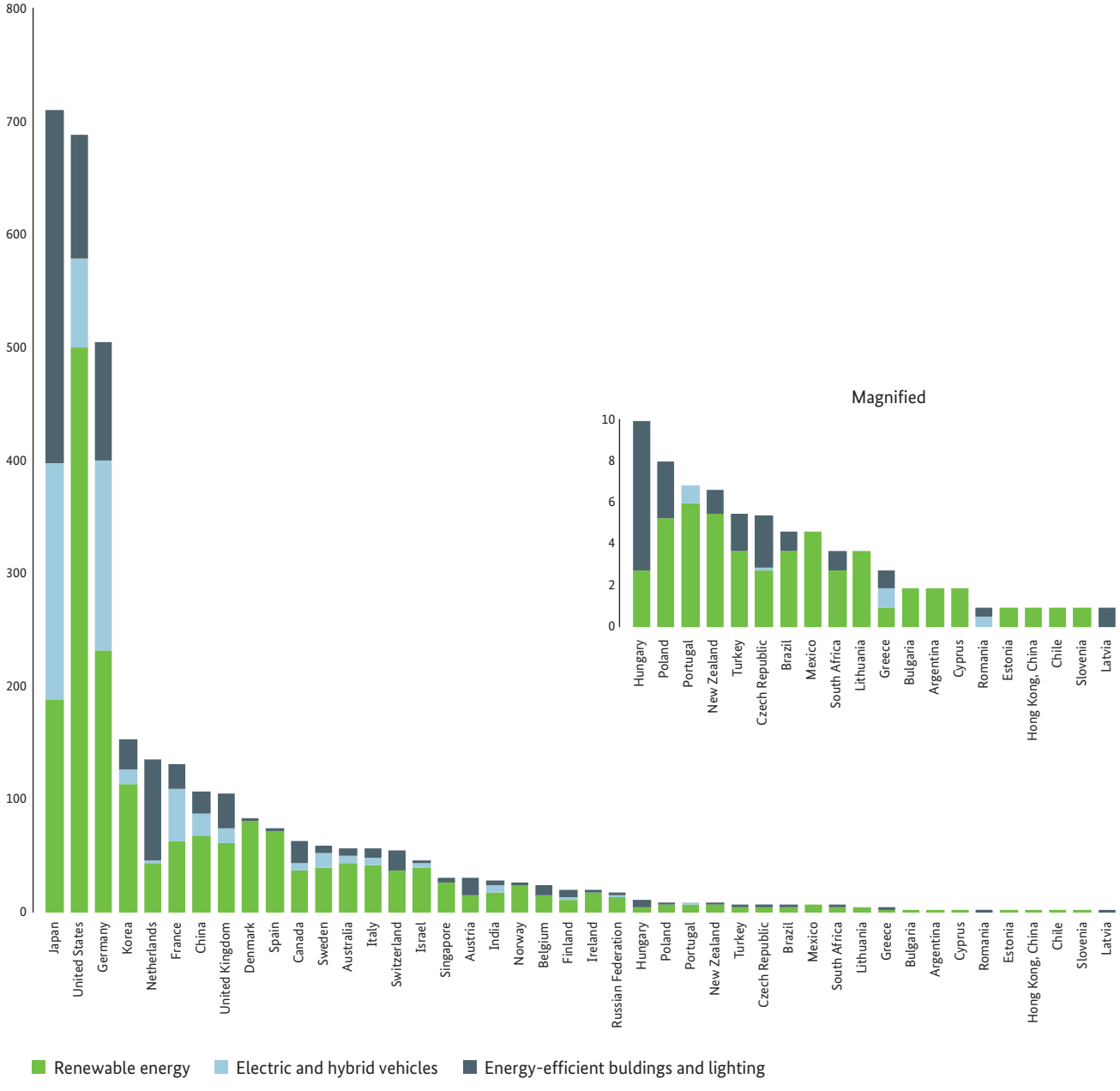
Regarding the private sector it is important to note that in developing countries the business models of many older companies, which were protected against international competition for a long time, only needed to cater to a local or national market. This led to an overall underperformance in innovation-related activities, as the market structure enabled them to achieve high profits without the need to invest in costly R & D or risky innovations.

While the macroeconomic conditions have changed significantly in the last two decades, the number of companies that have managed to adapt to the new paradigms of open markets and international knowledge-based competition is still relatively small. In some cases globalisation has even reduced innovative capacities in developing countries. This has happened, for instance, where local companies have been integrated into global consortia through mergers and acquisitions, with the R & D activities being transferred to the headquarters. In most developing countries, the rate at which new, more innovative companies are founded is still relatively low. Again, however, we should remember that the empirical evidence regarding these newly established companies is extremely limited.

In general, relatively few enterprises actively pursue a strategy of innovation or technologically oriented competitiveness aimed at the larger and more demanding markets (Europe, USA, increasingly China). Some of those which do so (often, but not always, formerly state-owned) comprise a group of multinational enterprises from the South *(Dörry/Stamm 2009, GIZ 2011a)*, such as Suzlon from India or Sasol from South Africa.

14 Data taken from the most recent version of World Bank's World Development Indicators: http://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS

Figure 1: Patenting of climate change mitigation technologies (2008)



Source: OECD (2011b, p. 30f)

A study recently published by the OECD drew on the organisation's patent database *(OECD 2011b, p. 28 – 32, see figure 1)* to analyse the international distribution of patents under the Patent Cooperation Treaty (PCT) as of 2008. It looked at patents in the following areas:

- electric and hybrid vehicles
- energy efficiency in buildings and lighting
- renewable energy (including so-called 'clean fossil fuels').

To summarise the study briefly, overall patenting of technologies for climate change mitigation is today dominated by a small number of OECD countries. These are primarily Japan (strong in energy efficiency in buildings and lighting), the United States (renewable energies) and Germany (relatively even distribution across the three fields). Of the BRIICS countries (Brazil, Russia, India, Indonesia, China and South Africa), only China achieves a top-ten position (ranked seventh, between France and the UK). India takes place No. 19 (behind small countries like Singapore and Austria). A number of sector-specific patent analyses also confirm the suggestion that patenting of Eco-Innovations to date is nearly exclusively confined to the OECD member countries. See, for instance, Braun et al. *(2009)* on concentrating solar power, or the OECD *(2011c, 204)* on wind energy. The only countries bucking this trend to some extent are China, followed at a significant distance by India. At present it seems impossible to judge how fast China and India are catching up, or if this will significantly change the global innovation landscape *(Altenburg/Schmitz/Stamm, 2008)*.

3.2 The demand side of Eco-Innovations in developing countries

No comprehensive analyses are currently available on the demand for Eco-Innovations in developing countries. For an approximate indication we can draw on two bodies of literature:

- the relatively large collection of literature related to global value chains and value chain governance *(e.g. Stamm, 2004 and 2008, Stephan/Stamm, 2009);*
- the much more recent discussion of the emerging middle classes in (advanced) developing countries *(e.g. Guarin/Knorringa 2012).*

The literature on global value chains indicates that, today, many companies in developing countries do not act in anonymous spot markets. Instead, they are embedded in networks shaped by longer term relationships with the lead firms (most commonly located in industrialised countries), which organise their supply chains according to the demands of consumers and markets. Such being the case, international value chains can trigger Eco-Innovations, because the lead firms either demand compliance with basic standards (food security, hazard avoidance) to protect their own business interests, or they endeavour to penetrate special 'green' niche markets that often generate above average profit margins (organic food, fair trade, green cotton). Globalisation and the integration of firms from developing countries into global value chains can stimulate business-to-business demand for Eco-Innovations *(Brandi 2012)*.

While research findings indicate quite clearly that the formation of global value chains can trigger environmental improvements (and thus promote Eco-Innovation) within companies and production systems in developing countries, the role played by changing local consumption patterns is evidently an under-researched issue. Until recently, the increasing importance of environmentally (and socially) responsible consumption has been mostly associated with relatively rich and well educated consumers in the industrialised countries. Now, however, important changes can be observed in developing countries, mainly in the rapidly developing anchor countries, or 'rising powers' *(Guarin/Knorringa 2012)*. The empirical evidence, however, is still extremely limited.

The most important observation in this regard is the emergence of a new middle class in a number of developing countries. Two related things can be inferred from this. Firstly, people emerging from poverty might base their consumer behaviour on more than just price considerations. Secondly, it is possible to assume that economic globalisation, increased connectivity through telecommunications, and the expansion of international brands might interact to shape a global consumer culture that, as well as other attributes such as pleasure, style and taste, includes elements of 'responsible consumption' *(Guarin/Knorringa 2012, p. 6)*.

At this point in time, it is impossible to make an empirical assessment of the extent to which the emergence of a new middle class triggers responsible demand, thereby encouraging Eco-Innovations on the domestic market, irrespective of the important globalised value chains. It is more likely that, in the near future, different trends will co-exist in most countries, with potentially conflicting environmental impacts, such as a rapid increase in the number and power of private motor cars alongside growth in the market share of organic food products. The experiences of the industrialised world show that consumer preferences can be influenced by the education system, NGOs, media, etc.

Capacities for Eco-Innovation are essentially a variation of general innovation capacities.

Sorting reusable materials in a recycling plant, Costa Rica

4. Promotion of Eco-Innovations through economic policy advice and private sector development programmes

This chapter explores options for fostering Eco-Innovation in the partner countries through German development cooperation in the field of private sector development. Its structure mainly follows the approach devised by the Working Group on 'Promoting Innovation Systems' *(Arbeitskreis Innovationssystemförderung),* which takes into consideration three different levels of intervention:

- Reinforcing the sub-systems (micro and meso level) of innovation systems
- Building bridges and links between the different sub-systems
- Improving framework conditions

Before exploring possible donor interventions in these three fields, we provide some pertinent ideas that may help project officers and decision makers identify the most promising starting points and approaches.

4.1 Identifying possible entry points for interventions

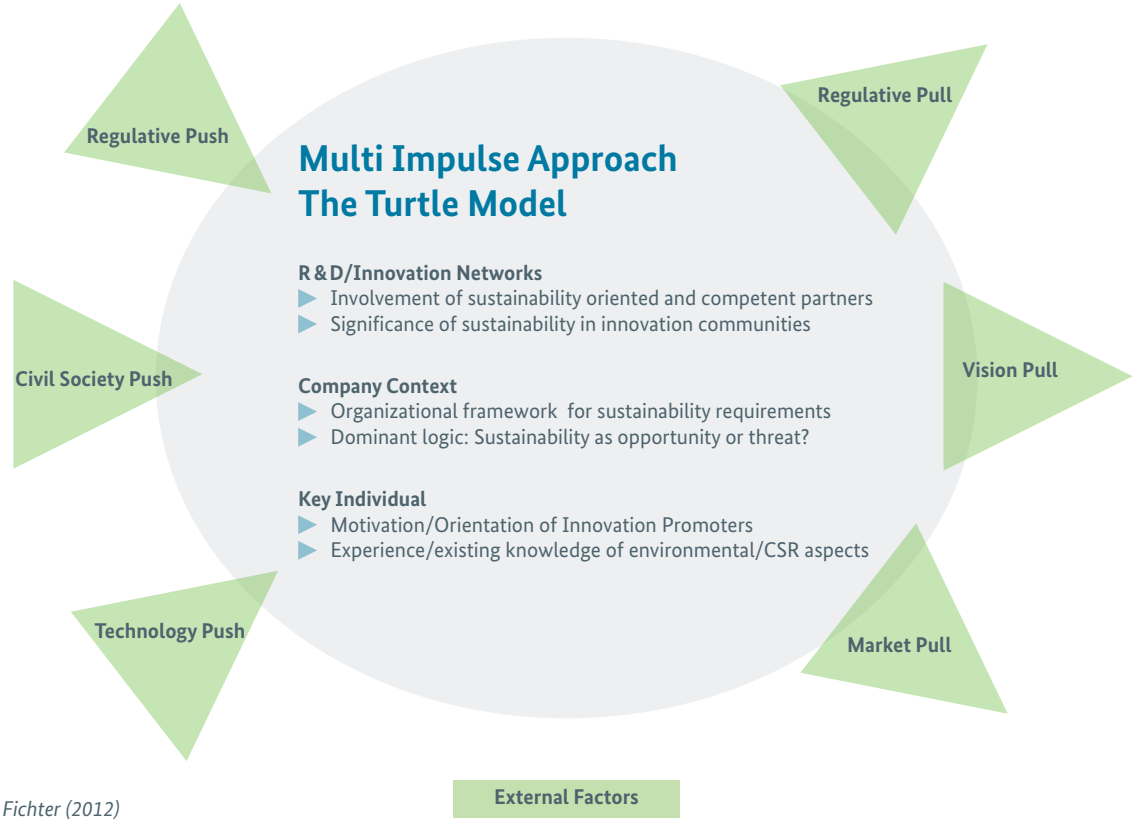
Interventions at the meso and micro levels of the Eco-Innovation system can be geared towards either the supply-side (technology potentials) or the demand-side (technology needs) of the system, or they can combine supply-side and demand-side approaches. Assessing the technology potentials and needs of a country and its national economy is a complex undertaking. On the supply side, in most countries no specific analyses of Eco-Innovation potentials are available. However, relevant reports have been published by international organisations examining innovative capacities in a broader sense. This does not (yet) happen regularly. UNCTAD publishes its STI Policy Reviews, and the OECD issues Reviews of Innovation Policy. Although their titles indicate a focus on policy-making, both of these reviews provide analysis of the relevant innovation systems, as well as the policies that have an impact on them. Neither focuses specifically on potentials for Eco-Innovation. However, where up-to-date policy reviews do exist, they can serve as a short-cut to a full assessment of Eco-Innovation policy-making. In countries where no such reports exist, an option could be to adapt the methods developed by UNCTAD and the OECD to develop a knowledge base for designing appropriate interventions. It might also make sense to contact both these international organisations, to find out if there are any reviews in the pipeline for the countries in question.

On the demand side, Technology Needs Assessments (TNA) for climate change are an important basis for identifying suitable development cooperation interventions. UNDP and UNFCCC have developed comprehensive methods for conducting such needs assessments *(UNDP/UNFCCC 2010).* A series of country needs assessments have been carried out as part of the UNFCCC process. Although these assessments concentrate on climate change, by looking at mitigation and adaptation needs together they provide important insights into the demand-side of Eco-Innovation in a broader sense. For instance, the 2007 needs assessment for South Africa *(DST 2007)* covers the energy, transport, agriculture, forestry, water, human health, built environment and infrastructure sectors.

In the many cases where no comprehensive supply and/or demand side assessments of Eco-Innovation exist, another option is a rapid appraisal, which can be carried out based on a limited set of stakeholder interviews, expert dialogues and/or group discussions. Such an appraisal should start from a set of hypothesis about which factors could trigger Eco-Innovations in the private sector.

Fichter *(2012)* proposes a 'turtle model' that combines internal (i. e. the actors within a given value chain) and external (those not directly linked to the value chain) driving forces of Eco-Innovation (see Figure 2).

Figure 2: The turtle model of drivers for Eco-Innovation



Source: Fichter (2012)

The clear strength of this model is that it comprehensively maps the possible drivers of Eco-Innovation and can therefore serve as a method for identifying potential entry points for Eco-Innovation policy-making and related donor interventions. However, as the model was developed in the context of industrialised countries, some adaptation is probably necessary for using it in developing countries. This refers mainly to the internal drivers, within value chains. The assumptions that there is close interaction between R & D and companies, and that innovation communities and/or innovation promoters exist, mainly reflect the reality of industrialised and newly industrialised (Korea) countries, or developing countries with very advanced technological capacities in certain sectors (Brazil, China, India, South Africa). Whether or not existing and emerging environmental values in the private sector and the related aspects of corporate social responsibility (CSR) can really trigger Eco-Innovations in developing countries is an interesting question. It must remain unanswered at present, due to a lack of relevant empirical evidence.

Four of the six external factors of the turtle model are clearly also relevant for most developing countries: market pull, regulatory push and pull, and civil society push. A push for technology from within a society can only be expected in very few developing countries which have an advanced science system, capable of pushing new technological knowledge into the value chains. In countries with an intermediate level of technological capacity, actors (such as internationally trained researchers) might exist, who can function as global listening posts, identifying new scientific discoveries and radical innovations, and translating them to fit the opportunities and needs of the domestic private sector. However, there is little empirical evidence that this happens in practice.

The extent to which societal or political visions can trigger Eco-Innovations has also yet to be demonstrated empirically. In the best case scenario, a vision is shared by a broad alliance of actors from government, the private sector and civil society, which involves the general transition towards more environmentally friendly development (green growth); this in turn boosts the confidence of entrepreneurs and investors that the rules of the game have changed for the long term, which might incentivise corresponding investments in STI.

However, a convincing, empirically backed example of this is still missing. The difficulties experienced by Germany's 'energy transition' in the second half of 2012 would rather suggest that visionary strategies can be relatively short-lived once the hard slog of complicated negotiations between the stakeholders begins and, as in this example, at least some parts of the population are subjected to price rises. Roughly one and a half years earlier, the German Government had announced the ambitious strategy of phasing out nuclear energy while at the same time maintaining its commitment to significantly reduce CO_2 emissions. This vision was (and still is) shared by a wide majority of the German population. However, sharing the vision is not the same as giving one's full support for the concrete formulation and implementation of policies.

Rapid appraisal of potentials for Eco-Innovation

A rapid appraisal of the potential for Eco-Innovation should always start with the demand side: i.e. the existing, emerging and prospective demand for more environmentally friendly solutions. It is usually easier to fill in gaps in the supply situation (e.g. through technology transfer or targeted capacity building measures) than to develop, expost, a demand for new, locally generated products, processes or services. Innovation policy assessments have shown that the supply-side promotion of innovation is not only very expensive, it has also rarely produced the desired outcomes on the ground *(OECD 2011d, 9f)*.

Below is a possible checklist for identifying demand-side entry points for interventions to promote Eco-Innovations (the questions are not listed in order of importance).

Market pull factors

- To what extent do changes in the prices of inputs (including energy) encourage companies to improve the eco-efficiency of their production processes?
- To what extent do changes in consumer preferences in the domestic market trigger higher environmental standards?
- Are new markets opening up for environmentally friendly products and services, e.g. among an emerging (often urban) middle class with a higher demand for healthier, more environmentally friendly products and services?
- Are more demanding markets of this kind emerging in neighbouring countries – e.g. in regional anchor countries – and are these markets accessible to local producers?
- To what extent do increasingly rigorous targets set by the lead firms of global value chains force local supplier companies to introduce Eco-Innovations? How are these targets passed on to tiers further down among the (national) suppliers?

Civil society push

- To what extent do an active civil society or critical media induce or force companies to improve their environmental performance?
- Is the role of environmental standards and labels increasing in the national, regional and global markets? These are often promoted by civil society organisations and/or environmental movements (e.g. Forest Stewardship Council (FSC), Marine Stewardship Council (MSC), organic farming groups)?

Regulatory push and pull factors

- To what extent do new public regulations (e.g. on air or water pollution) oblige companies to implement Eco-Innovations in their production processes?
- Is the introduction of new regulations to be expected – for instance, because the country has committed itself to internationally agreed environmental targets, or because regional integration schemes require more stringent environmental standards?
- To what extent is the public sector using its procurement processes to stimulate Eco-Innovations in the private sector, e.g. in the construction and infrastructure sectors? Can public authorities be persuaded to do so?

A checklist for the supply side is much more difficult to create, as the drivers of innovation can include many, highly diverse actors, and because the turtle model does not seem directly applicable in the context of developing countries. The literature available on innovation systems suggests there is a need for the comprehensive mapping of relevant public and private actors, their strengths and weaknesses, the links between the actors, and the gaps within the networks. Many such maps can be found in the UNCTAD and OECD studies mentioned above, although they only address the countries for which a review has been completed.

In many, mainly less developed, countries, such a mapping process will inevitably reveal a series of blank spots and missing links and might therefore be rather frustrating. We have to start from the assumption that many developing countries simply do not have the kind of institutional structures that can meaningfully be labelled a national innovation system. Instead, there are pockets and islands of innovativeness, or even individual entrepreneurs with an innovative spirit, in otherwise static and traditional economies – and these should be the starting point for donor interventions. Here, a promising approach would seem to be to work with the idea of a 'seed' or 'insular' innovation system. In more advanced developing countries, the situation is more likely to correspond with a fully fledged innovation system. Some ideas of how to seed Eco-Innovation systems are listed in Chapter 4.2.1 (see below).

4.2 Reinforcing the sub-systems of innovation systems

Even if there are no fully fledged innovation systems in place in many partner countries, donor interventions should still take the innovation system approach as a guide when designing activities that will, in the long run, contribute to effective innovation systems adapted to the specific conditions of the country or world region.

4.2.1 Identifying and supporting ecologically innovative entrepreneurs and SMEs

In many countries, a first important step might be to identify a limited number of individuals or groups who are willing to introduce Eco-Innovations in their country. These potential 'seedlings' of Eco-Innovation systems could include:

- existing SMEs, farmers' cooperatives or NGOs that wish to bring environmentally friendly products to the local, regional or national markets, or that have partners abroad or donors to assist them in developing international value chains based on Eco-Innovations
- concerned individuals, SMEs or civil society groupings that endeavour to introduce environmental concepts in their local/regional contexts, such as recycling, solid waste treatment, composting of organic residues, etc. In many cases these concepts require the introduction of Eco-Innovations (new to the market)
- graduates from local training centres, high schools or universities who wish to use the knowledge they have acquired in Eco-Innovation-relevant fields, in order to start their own businesses (spin-offs)
- employees of large, national or international companies who wish to leave their employer in order to start their own businesses, based on Eco-Innovations (spin-out)

BOX 4

Eco-Innovation competitions: the example of the Berlin-Brandenburg Business Plan Competition (BPW)

Berlin and Brandenburg have held their annual business plan contests since 1995. This is the largest regional start-up competition, and is organised by the investment banks of the two federal states, and by the regional employers' associations. By 2004, 2,679 business plans had been submitted, 620 companies founded and around 2,500 jobs created. Entrepreneurs are given assistance with three steps, from the initial business idea, to a solid and feasible concept, and the launch of their new company. The organisers of the BPW share their knowledge, provide tailored advice and help establish useful networks. The best business plans win financial support, which is currently worth EUR 65,000. In 2005, specific modes were introduced for company start-ups in the service and technology sectors. More recently, in 2011, the BPW Sustainability *(Nachhaltigkeit)* was introduced. During the first phase of its introduction, the entrepreneurs can volunteer to add sustainability-oriented chapters to their business plans, but in the future, all the business plans will have to include a comprehensible sustainability strategy.

For more details see: https://www.b-p-w.de

- returning migrants, e.g. young people who have received training abroad and want to apply their knowledge of Eco-Innovations in their local or national context, either in a university or research centre, or as an entrepreneur (in many cases, both simultaneously)
- web-based international networks of researchers and related stakeholders, such as the Open African Innovation Research and Training (Open A.I.R.) project (www.openair.org.za)
- immigrants, i.e. individual expatriates who decide to reside in a developing country and wish to apply their knowledge of Eco-Innovations in order to make a living.

The great diversity of this list of individuals and groups who can act as potential 'seedlings' for national Eco-Innovation systems gives rise to two questions:

- How can these individuals and groups be identified?
- How can they be supported with the given instruments of private sector development?

In many cases, especially in smaller and less diverse developing countries, most of the potential Eco-Innovation innovators can be identified relatively easily through interaction with national promotion agencies (export, trade, agriculture and industry), or with donors active in private sector promotion, rural development or similar fields.

From the point of view of German development cooperation, a useful pool of entrepreneurs with a potential interest in Eco-Innovation are individuals from partner countries who are studying at, or who have graduated from education and training courses in Germany, for example at technical universities. Their studies might have been financed by DAAD or other funding agencies, or they might have paid their own way. Having trained in an entrepreneurial environment, these young professionals represent a significant potential for the formation of ecologically innovative enterprises in partner countries and could be approached quite easily through alumni networks, etc. It is also worth considering approaching such people while they are still in Germany. This would also provide them with an opportunity to partake in entrepreneurship courses in Germany, and perhaps to identify German companies willing to assist them in establishing their own businesses on their return home, for instance as part of those companies' CSR programmes.

As well as identifying ecologically innovative entrepreneurs, an interesting approach would be to stimulate the generation of new business models in the field of Eco-Innovation. This could take place, for instance, at universities, in the business studies departments as well as for the more technological and science-based fields. For example, the University of Oldenburg recently launched a course in Eco-Entrepreneurship for its business students. This consists of two modules of theory (innovation management and entrepreneurship) as well as a practical module, 'eco-venturing'. In the practical module, students design

business models (often not technology-based) together with existing companies, and they take them to the start-up phase. At this point, both sides decide whether the idea will be taken up by the company or used as a seed-bed for a spin-off by the student.[15] On the other hand, equipping students in technological, science-based fields with business skills could lead to the creation of new Eco-Innovation based companies. This could be done either through entrepreneurship education courses integrated into the curricula at the university or through additional business classes for graduates with specific ideas and prototypes in the area of Eco-Innovation, possibly offered in a business incubator at the university.

Eco-Innovation competitions to identify (potential) innovative entrepreneurs and stimulate Eco-Innovation thinking

A more systematic way of identifying ecological innovators may be to hold dedicated competitions. To help to enhance their visibility, these could be carried out in cooperation with regional or national mass media (newspapers, television broadcasters, and social media). Visibility and positive image-building can also be achieved if a national 'champion' is attracted as a partner, e. g. a prestigious (retired) entrepreneur or former politician, or a well-known sports personality. Since the 1990s, start-up and business-plan competitions have mushroomed in Germany, with varying degrees of success.

Eco-Innovation competitions can target either entrepreneurs at an early stage (Eco-Innovation start-up and business plan competitions) or SMEs that are already well established (Eco-Innovation entrepreneur of the year). The fundamental idea of Eco-Innovation competitions can easily be transferred to other target groups and objectives, for instance to identify creative and feasible solutions to environmental problems of local communities (waste reduction and recycling, innovative models of local public transport, etc.). Such idea competitions would not directly form a part of private sector promotion, but the emerging ideas might well provide the basis for feasible Eco-Innovation business models.

BOX 5

Innovative ways to promote university spin-offs: EXIST in Germany

In the 1990s German policymakers were concerned by the fact that the rate of business start-ups, specifically of technology-oriented enterprises, was low in an international comparison. As a response, in 1998 the German Federal Ministry of Economics and Technology (BMWi) launched EXIST – a university-based business start-ups programme. This is intended to improve the entrepreneurial environment at universities and research institutions and increase the number of technology and knowledge based business start-ups. Regions with technically oriented universities were invited to submit proposals for how regional networks made up of research and education centres, public administration, local banks and other stakeholders would work together to improve the entrepreneurial culture, the development of promising business plans and the transfer of research outcomes into private sector practice.

Between 1998 and 2005 15 regional EXIST networks have received support, EUR 44 million have been invested in two phases (EXIST I – Model regions, and EXIST II – Transfer). Third party evaluations describe a rather mixed picture, regarding the impact of EXIST. Up to 2008, Egeln *(2010)* could not identify a significantly higher rate of business start-ups in the EXIST regions, compared with other university regions. There was not even a significantly higher propensity among university staff or graduates to attempt to form their own businesses. What the same author cites as positive is that business start-ups in EXIST regions have easier access to local and regional support institutions. Also, the research and technology orientation of business start-ups was higher in EXIST regions. Shortly after the conclusion of EXIST II, Kulicke et al. *(2006)* saw positive impacts in the establishment of a sustained entrepreneurial culture and entrepreneurial education at the universities.

Sources: Kulicke et al. (2006), Egeln (2010)

15 www.innovation.uni-oldenburg.de/58589.html

BOX 6

The InnoRegio contest to boost innovation in Germany's declining eastern regions

The InnoRegio contest was launched in 1999, with the objective of fostering innovative network building in the eastern part of Germany, a region which had lagged behind the country's average economic development ever since reunification. InnoRegio did not restrict the ideas to be supported to specific sectors or technologies. Rather, the networks were encouraged to submit proposals based on a joint assessment and creative utilisation of specific regional potentials. There was a very big response to the call by the German Federal Ministry of Education and Research (BMBF), with 444 networks submitting proposals, of which 23 received funding. A third party evaluation in 2005 came to a very positive assessment. Most of the companies involved in the competition saw their competitive position strengthen. Networking and mutual learning among actors in the region was enhanced, and some positive employment effects were registered. More significant outcome was expected in the long run.

Source: Dohse (2005)

Competitions of this kind can achieve more than just identifying existing and potential ecologically innovative entrepreneurs. The German EXIST competition, that started in 1998 (see Box 5), is known to have strengthened entrepreneurial culture in the regions involved, and it planted the idea in the minds of many technically trained persons of starting their own businesses. It should be observed that the competition did not generate very many direct university spin-offs. However, numerous graduates from technical universities first started working for existing companies before launching their own businesses some years later, having acquired the appropriate hands-on experience. Thus, targeted competitions of this kind seem to influence the meta-level of systemic competitiveness – in other words, the values and attitudes. Of course, no sweeping benefits can be expected in the short run. Nevertheless, Eco-Innovation competitions with high visibility and possibly also with a widely recognised celebrity sponsor can help to entrench the concept of Eco-Innovation within a large population. They inspire positive connotations and promote the idea that Eco-Innovations can provide the basis for attractive business concepts.

Finally, business competitions can also induce network building and the creation of a cooperation culture among companies, or among different stakeholder groups in a geographically limited area. In Germany in the 1990s, STI policy-makers were concerned that the country was losing ground in the field of commercial biotechnology, compared to other leading industrial countries, such as the USA and UK. The BioRegio competition (see Box 7) was devised in reaction to this perceived (and probably real) comparative disadvantage. The fact that only regional consortia were eligible for funding, and that they had to include at least one actor from the private sector, one from a publicly funded research body, and one from the public administration, encouraged network building and, to some degree at least, a culture of cooperation across sectors. This happened even in regions that did not ultimately progress in the competition, and did not immediately receive public funding.[16]

While the model of the BioRegio competition can only be replicated in areas with a greater density of innovative companies and public research organisations, the InnoRegio competition (Box 6) may provide more lessons for developing countries, where these elements of strong innovation systems are still lacking. The InnoRegio competition was based on the model of the BioRegio competition, with the exception that no specifications were given in advance regarding the content of the innovative projects to be proposed. The main objective of the InnoRegio competition was to stimulate innovative thinking and network building in eastern Germany, where most areas were lagging behind the national average after the structural changes following Germany's reunification.

16 In several cases, the networks continued working and acquired funding for their projects at a later stage, either from BMBF or other funds (e. g. EU).

BOX 7

Catching-up in commercial Biotechnology – Germany's BioRegio competition

The BioRegio initiative was an instrument for the promotion of commercial biotechnology in Germany, which ran from 1997 to 2005, at a total cost of EUR 90 Million. The core idea behind BioRegio was to channel funding to regional networks that submitted feasible projects for the development of commercially viable innovations in biotechnology, and that won the competition based on a neutral assessment of the proposed concepts. The competition did not define in advance the areas or sectors in which the networks were to develop commercial solutions. To qualify for the competition, consortia had to be established consisting of at least one publicly funded research organisation, one private company and one stakeholder from the public administration (municipality, regional government). 17 regional networks participated in the BioRegio contest, three of which received support between 1997 and 2005. Building upon the success of BioRegio, in 1999 the BMBF launched the BioProfile Initiative, worth an overall volume of EUR 100 million. Unlike BioRegio, the application fields were limited. The winning regions promoted research into nutrition-related illness, improved diagnostics and therapy, and regeneration biology. Evaluations of both BioRegio and BioProfile have shown that the instruments prompted a significant increase in the numbers of biotech business start-ups. Sales figures and employment also grew much more rapidly in the winning regions than in other German regions.

InnoRegio stimulated significant creative network building. 444 regional projects were submitted for funding, some of which focused on traditional industrial strengths and technologies, while others simply presented creative concepts without any significant technology content. Examples of the latter included a concept to develop tourism specifically for people with physical disabilities.

These experiences from Germany demonstrate that open and publicly visible competitions are an especially useful tool for promoting creativity and innovative thinking, and that they also encourage network building within and across sectors. They are seen to have an important leveraging potential, mobilising a greater impact per invested unit of money than other promotion schemes.

Two generally similar competitions run by the Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) in 2011 and 2012 (Box 8, Box 9) seem clearly to confirm, that the same results can be achieved in the context of developing countries. Here, probably more than in OECD countries, awareness raising activities are a very important element of the competition, for the following reasons.

- They make it clear that innovation is not something limited to laboratory research and high-tech businesses, but can be borne by the local community, based on their creativity and willingness to change.
- They sensitise people about environment-related challenges as well as the opportunities to overcome them.

So we can recommend that the competition model of Eco-Innovation promotion deserves to be thoroughly evaluated, and that, based on the results, activities in this area should be broadened and scaled-up. However, based on the experiences in Germany, two lessons or caveats should be remembered.

- Competitions that address network building or more fundamental issues related to values and norms (e.g. entrepreneurial culture) will not usually have a measurable hard impact within a few years, other than the micro level result of individual enterprise formation. Such initiatives might therefore require special tools to evaluate.
- Most of the innovation-oriented competitions in Germany have had a regional focus. The accompanying research stresses that regional competitions may have different and conflicting goals, such as either to stimulate growth or equalise regional disparities. In the first case, the competition will try to identify those regions with the highest potential to boost national and/or sectoral growth (e.g. BioRegio). In this case, regional imbalances might become more acute. In the second case (e.g. InnoRegio) promotion schemes will support regions that are lagging behind. While addressing equity issues, the contribution to the overall growth path will usually be limited.

As a preliminary summary, although competitions may be an extremely helpful instrument to identify and mobilise individual entrepreneurs or networks of (potentially) innovative actors, it is essential from the outset to define the concrete objectives linked to the instrument (growth-oriented or equity-oriented?). Furthermore, it is important to maintain realistic expectations regarding the time it will take to achieve any significant impacts.

Supporting the formation and growth of Eco-Innovation-based companies through financing

Accessing finance is one of the main barriers to the development of MSMEs in developing and emerging countries. This is especially true of start-ups and enterprises that develop innovative products and technologies. Financing such enterprises involves specific risks for financial institutions, including the lack of a business track record, lack of knowledge about the new technology or product, lack of information about demand, etc. These multiple risks, as well as the lack expertise on the part of financial institutions in many countries, discourage those institutions from investing in Eco-Innovations, or they raise the cost of lending to a level that is unaffordable for most entrepreneurs. Therefore, there is a need to promote the financing of Eco-Innovations by providing incentives to financial institutions to increase their investments in this sector, by helping them to cope with the associated risks and by providing adequate refinancing. In this respect, the use of grants or subsidies might also be a viable solution for promoting Eco-Innovations.

German development cooperation includes various approaches for alleviating the financing constraints faced by start-up and innovative enterprises, including those enterprises that contribute to a green economy and the use of Eco-Innovations. Significant expertise and accumulated experience are available in the two main fields of intervention in German development cooperation: financial cooperation and technical cooperation.

In this regard, the development of inclusive financial systems is the guiding principle of German development cooperation. That includes promoting conducive conditions and strengthening service providers within the financial sector, providing adequate refinancing options

BOX 8

Promoting green innovation and sustainable responsible entrepreneurship: the ZERO Award in Egypt and Ethiopia

The ZERO Award aims to spread the idea of environment-friendly innovations as a basis of sustainable development. The first competition for the ZERO Award, which was carried out in Egypt in 2011, was rather generic. It addressed the efficient use of the limited resources in Egypt as one of the main challenges facing the national economy. In this context, innovation was considered indispensable. The outcome was judged to have been successful by GIZ and a second competition was launched in Egypt, Ethiopia and Germany in 2012. The competition has the following concrete objectives.

- Promote green innovation.
- Raise awareness of the importance of local solutions.
- Encourage out-of-the-box thinking and entrepreneurial culture.
- Highlight the significance of environmental protection and climate change.
- Link innovators with the private sector and financing channels.

Egyptian nationals (students, individuals, companies, professionals, researchers, etc.) who had a green innovation appropriate to local conditions were invited to submit proposals. These were selected in a twofold selection process. The six shortlisted candidates all received initial training and were invited to present their projects at the ZERO Award closing ceremony. A high-level jury then selected the three winners.

The second competition launched in 2012 was given the theme of sustainable construction. Parallel activities were launched in Egypt, Ethiopia and Germany, and a concept was developed for a week-long workshop in Cairo to provide specific training and encourage international exchanges.

Sources: ZERO Award concept paper (in German, unpublished).

and capacity development for the financial institutions, and developing the financial capacities of (potential) customers of financial institutions. Each of these areas of assistance involves their own particular activities that are especially relevant for the promotion of Eco-Innovations.

- Conducive conditions: On behalf of the German Federal Ministry for Economic Cooperation and development (BMZ), GIZ promotes green regulation of the financial sector in its partner countries. In India, it has recently set up a programme that aims, among other things, to mainstream environmental, social and governance standards within the financial sector. This includes creating awareness among financial institutions and impact investors of the business potential of Eco-Innovations.

- Provision of capital: KfW Development Bank provides capital to innovative entrepreneurs, for example through green credit lines, such as the Green for Growth Fund and the Global Climate Partnership Fund. Both of these funds provide money to financial institutions which use it to lend to selected enterprises or, in some cases, for direct investments in project developers.

- Product development: Furthermore, financial institutions might need to introduce specific credit products for certain technologies. These require special credit terms and conditions and a specialized knowledge of the financial institutions' staff. Such product development is an integral part of financial sector development programmes.

Programmes and projects aimed at emission reductions, climate change adaptation and technology transfer in developing and emerging economies are financed with a differentiated mix of grants, low-interest loans with long maturities (for instance as development loans, promotional loans and credit lines) or equity participations. Particularly for environmental and climate protection a multitude of special facilities and programmes are available. This range is complemented by innovative approaches such as fund solutions that encourage private sector investment.

BOX 9

Financing the early stages of Eco-Innovations: the Seed Capital Assistance Facility (SCAF)

The SCAF is aimed at helping energy investment funds in Asia and Africa to provide seed financing to clean energy enterprises and projects in their early stages. The Facility is implemented by the United Nations Environment Programme, the Asian Development Bank and the African Development Bank. SCAF aims at addressing problems of transaction costs and the insufficient returns offered by small, less mature and more risky clean energy ventures. Support Line 1 ('Enterprise Development Support') helps entrepreneurs in the development of their business, through match-making activities, coaching and financing of feasibility studies. Support Line 2 ('Seed Capital Support') co-finances parts (typically 10% to 20%) of the seed capital for the early-stage development of clean energy project and enterprise.

Source: http://scaf-energy.org

Following the approach of „sustainable energy finance through the banking sector", KfW Development Bank has introduced corresponding financing products for credit institutions in the partner countries. To finance investments in energy efficiency and renewable energies it provides partner finance institutions with long-term credit lines. This enables them to make financing available for investments by MSMEs and private investors in the housing industry, thus fostering climate and environmental protection.

Apart from the German contributions, the international community supports numerous activities to promote the financing of Eco-Innovations. International funds are available for financing green investments, technologies and innovation, one example being the SCAF run by UNEP, African Development Bank (AfDB) and Asian Development Bank (ADB) (see Box 9). Other examples are the Clean Development Mechanism (CDM), the Clean Technology Fund (CTF) and the Strategic Climate Fund (SCF). Funding earmarked for green growth is also available from donors and the multilateral banks for the promotion of Eco-Innovations.

BOX 10

Financing innovative MSMEs in India: the SIDBI-KfW programme

The SIDBI has entered into a loan agreement with KfW in Germany worth EUR 53 million, to be used for its MSME Innovation Finance Programme. This is designed to promote entrepreneurial innovations, particularly those relating to clean technologies. Another objective of the programme is to catalyse the development of financing instruments specifically tailored to the requirements of innovative MSMEs. This assistance will be provided in the form of loans and risk capital assistance as well as quasi-equity products.

Sources: Working Group on 'Promoting Innovation Systems' (Arbeitskreis Innovationssystemförderung, 2011), www.sidbi.com

A new programme that KfW is implementing in cooperation with the Small Industries Development Bank of India (SIDBI) is specially targeting the financing needs of innovative SMEs, especially in the field of clean technologies (Box 10). To date, most of these funding mechanisms are still rather new, and their impact on technology transfer or the building of local capacities for innovation is still low. However, these funds are expected to provide ample opportunities for co-financing national Eco-Innovation initiatives.

Supporting the formation and growth of Eco-Innovation-based companies with advisory services in the early stages of business development

One interesting tool to support entrepreneurs in starting a company and ensuring its growth is Competency-based Economies through Formation of Enterprise (CEFE). As similar approaches by ILO (Start and Improve Your Business – SIYB) and UNCTAD (Empretec, started in 1988)[17], CEFE offers tailored packages of training modules that help entrepreneurs to identify business ideas, start a business, improve the business and expand the business. CEFE has proven adaptable to different contexts and environments,[18] and it has already been adapted to help promote green entrepreneurship.

The programme of development partnerships with the private sector, DevelopPPP, is another instrument that can be utilised to support existing Eco-Innovation-based companies and promote the emergence of new ones. These might, for instance, link local agricultural companies in developing countries with leading firms in the most innovative sectors of the organics trade (agribusinesses, biopharmaceuticals, organic cosmetics). German companies in the relevant sectors may be willing to build up value chains with suppliers of inputs and semi-finished products in order to lower their costs. They may also wish to establish long-term relations with distributors of final products, or with companies providing maintenance and other support. Development partnerships can provide the companies with incentives to venture into new business relations, and can become important channels for the transfer of Eco-Innovation-relevant knowledge.

Assisting existing SMEs with environment-related product and process innovations

To induce more sustainable growth patterns requires a greater availability of environmentally friendly products on the domestic markets (energy-efficient household appliances that are easy to recycle). To a certain extent, this supply can and will be covered by imports from industrialised countries. However, in order to secure and enhance to the will for change in society and among political decision makers in developing countries, it is important to make sure that environmentally friendly development does not become associated with negative import-substitution practices which cause the loss of national value addition and employment. Consequently, there is a need to assist local companies in the development, production and marketing of environmentally friendly goods, and in acquiring the related management tools. The development of service markets for environmental management

17 www.unctadxi.org/templates/Startpage____7428.aspx

18 In 2007, for instance, SIYB published a manual for the inclusion of people with disabilities in standard training modules in China (www.ilo.org/empent/Publications/WCMS_101311/lang--en/index.htm)

and clean production in SMEs is an important tool in this regard. For example, Profitable Environmental Management (PREMA) has been used as a training approach in over 30 countries to increase the resource efficiency of SMEs.[19] Where it has been applied, PREMA has had a substantial impact in terms of cost savings and resource efficiency, either by encouraging the more effective use of raw materials and packaging, reducing the number of sub-standard products, or turning former non-product output into new products. However, establishing viable and financially sustainable markets for these services remains a challenge as the prevailing conditions often present different incentives affecting resource efficiency.

BOX 11

Keeping in touch with experts educated in Germany: the DAAD Alumni Special Projects programme

With its Alumni Special Projects, the DAAD supports experts from developing countries who have been educated in Germany, by establishing North-South expert networks on specific topics and facilitating cooperation projects with future business partners. The Alumni Special Projects are characterised by a two-phase structure. First, the alumni participate in a one-week summer school at a German university, then they attend a trade fair or industry event to update their knowledge with the latest developments and technologies in their field of expertise, and to establish contacts with industry representatives and to initiate possible cooperation projects.

Sources: Working Group on 'Promoting Innovation Systems' (Arbeitskreis Innovationssystemförderung, 2011), www.daad.de

In many cases, this support is mainly provided through the 'bridging' function of innovation system support, for example linking SMEs to service providers or advising government authorities on shaping public procurement systems that favour Eco-Innovations (see 4.2). However, in view of the specific need to promote Eco-Innovations rapidly and at a large scale, as well as the twofold market failure and the scarcity of ecologically innovative entrepreneurs, some kinds of micro-level intervention seem pertinent that would otherwise be more difficult to justify. These could include exposure trips for entrepreneurs or management staff to larger markets in the relevant region, to Europe or beyond. Visits could be arranged, for instance, to international trade fairs (Biofach, ANUGA etc.), or presentations organised of innovative products or services, including measures to establish contacts with relevant buyers. Such trips can help generate new ideas about viable Eco-Innovations, and they can help raise awareness about the quality standards that have to be met in order to sell ecologically innovative products and services.

4.2.2 Providing the right mix of human resources for ecologically innovative entrepreneurs

If innovative entrepreneurs wish to expand their businesses based on Eco-Innovations, from a certain level of enterprise development they will have to employ additional personnel capable of translating innovative ideas into everyday operations. In most developing countries, there is a wide-spread shortage of appropriately qualified staff at all levels. Empirical evidence suggests that, in order to turn an Eco-Innovation into a commercial success, the most important qualified staff an entrepreneur needs are technicians with intermediate level qualifications. These are the employees who convert the new product or service into something that satisfies the clients' requirements and expectations.

For strengthening the human resources element of innovation systems, Germany has a clear competitive edge thanks to its dual system of vocational training. The German dual system enjoys a high reputation in many countries. It provides future members of the skilled

19 www.premanet.net

workforce with basic and further vocational education and training, equipping them with enhanced specialist, methodological and social competences, and building the essential foundation for an innovative and competitive economy. Fostering Eco-Innovations in partner countries would frequently entail an important component for promoting technical training adapted to the local efforts to establish a greener economy. In South Africa, GIZ recently launched a project entitled 'Green Jobs for South Africa', which seems to fit this pattern.[20]

It should be stressed that, to facilitate successful Eco-Innovation in developing countries, there is often a greater need for broad-based intermediate level training than for a select group of people with higher qualifications. Developing countries are more likely to be able to launch Eco-Innovations that are new to their own market, rather than 'new to the world'. Companies that offer cutting-edge technologies can usually survive with limited sales figures for some time, as their competitive advantage and the protection schemes for intellectual property rights allow them to attain high profit margins. The situation is different for most new-to-the-market innovations.

Target groups in the national markets often have only limited purchasing power, which basically prevents innovators from achieving very high profit margins. In this situation, the success of an Eco-Innovation-based business depends on a sufficiently large-scale deployment of products or services and the assurance of high quality to help develop the domestic, or penetrate external markets. In South Africa, for instance, the National Solar Water Heater programme, launched in 2010, has set itself the target of installing one million units by 2014.[21] In order to achieve such an ambitious goal, a large number of technicians are required who are able to ensure the high quality installation of this relatively robust technology, as proper installation is crucial for the efficient capture of solar radiation and the resilience of the systems.

Climbing up the ladder of qualifications, Eco-Innovation systems also require engineers and technicians trained in adequate tertiary education programmes. Another qualification gap can be identified between the levels of vocational and technical training and university graduates. For a wide array of Eco-Innovations, there is a need to adapt world class technologies to local environments, whether that means just the basic natural conditions or the specific factor endowment of the country. Experts who can fill this gap will be able to conceptualise solutions based on their solid knowledge of the scientific basis of a given discipline, while still being able to ground that process in the daily practice and requirements of the business in question. In the case of Germany, this kind of theoretically based, hands-on knowledge is mainly imparted through the courses provided by universities of applied sciences (Fachhochschulen). This special model of higher education has only been transferred to developing countries in few cases to date. To make this kind of applied higher technical education a success, it is important to link the institutional knowledge transfer to activities which influence the values and norms that often encourage or hinder people in their choice of a technical rather than a typically white-collar education.

Finally, at the upper end of human resource development, a certain number of graduates are required from technical universities, with PhDs and post-doctoral qualifications, as this enables countries to keep up-to-date with fast-moving international developments in ecologically innovative disciplines. Here, it would be possible to use the well-established programmes of the German Academic Exchange Service (DAAD – e.g. the Alumni Special Projects, see Box 11), and the Alexander von Humboldt Foundation in a more systemic way. In this field, the needs are not only related to high-level technical expertise, but also to systemic knowledge of the required transformations for a society and economy that allows Eco-Innovations to flourish. An interesting programme in this regard is the international Climate Protection Fellowship, run by the Alexander von Humboldt Foundation and financed by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU).[22]

20 www.giz.de/en/worldwide/17848.html

21 www.engineeringnews.co.za/article/sa-solar-water-heating-programme-officially-launched-2010-04-28

22 www.humboldt-foundation.de/web/icf.html

4.2.3 Strengthening research and development for Eco-Innovations

Most developing countries see themselves as mainly the recipients of technology transferred from the industrialised countries – which indeed they often are. However, even in this case, it is essential that local capacities exist to search for, transfer, adapt and apply technological knowledge related to Eco-Innovations. More advanced emerging economies may even try to compete directly with the industrialised world in developing new technological knowledge and applying it to new products and services. This seems feasible, largely because the fundamental technologies are in greater flux than are the products and services that developed during earlier Kondratieff cycles (automotive technologies, mechanical engineering etc.). In the former case, it is important to build partners' capacities for the organisation of applied research in general, and the generation of viable Eco-Innovations specifically. Interesting partners in this context include the Fraunhofer Gesellschaft for applied research, the Fraunhofer Institute for Solar Energy Systems ISE, in Freiburg, the Fraunhofer Institute for Wind Energy and Energy System Technology IWES, and – for aspects of Eco-Innovations related to the social sciences – the Fraunhofer Institute for Systems and Innovation Research ISI.

Many developing countries are making an effort to increase their R & D spending, but they often lack instrumental knowledge for spending public funds effectively. Germany has a large repertoire of programme and instrument-oriented experience that it can share with the partner countries. Just some of the many topics that could be discussed include:

- channelling important parts of research budgets through an autonomous, self-governing body that brings together the main research implementing organisations, such as the German Research Foundation (Deutsche Forschungsgemeinschaft, www.dfg.de)
- promoting scientific excellence through competitive bidding (Exzellenzinitiative, the Excellence Initiative for Cutting-Edge Research at Institutions of Higher Education)
- bundling of resources in specific topical clusters (the framework programme Research for Sustainable Development – Forschung für Nachhaltigkeit; the High-Tech Strategy of the BMBF.

Any responsible approach to transferring institutional and instrumental knowledge should include a critical approach to one's own experiences.

4.3 Building links between the different sub-systems

One important topic for innovation policies is how to bring together actors from the various sub-systems of the innovation system. Three different settings should be distinguished.

- Horizontal linkages – within the same stakeholder group: here the main challenge is to promote cooperation between companies with complementary assets, including knowledge.
- Vertical linkages (1) – between actors in the publicly funded research system and the private business sector.
- Vertical linkages (2) – between the providers of innovative solutions and the (potential) users, be it commercial clients, public entities (schools, public housing or water authorities) etc.

Companies are usually extremely reluctant to establish horizontal linkages with their peers. This is especially true of companies whose competitive advantage lies in their specific knowledge-based advantage rather than, for instance, their built production capacities and related economies of scale. These companies fear losing their competitive edge if their rivals gain access to formerly secret proprietary knowledge. In this respect, managers and decision makers will regard networking between companies more as a risk than as a potential benefit.

The same thinking also prevents companies from establishing closer vertical linkages with publicly funded research organisations, as even this can result in strategic knowledge leaking out to competitors *(Mansfield 1985)*. Other factors hampering collaboration between private business and public research include the different motivating factors (patents versus publications), time considerations (first on the market, versus scientifically well founded results) and even language issues (practically oriented, comprehensible language as opposed to the jargon of a scientific community).

The importance of vertical user-producer linkages for effective innovation processes was recognised in the academic literature of innovation at an early stage *(Lundvall 1985)*. However, this insight has rarely been translated into policy measures to promote innovation. Bringing innovators and (potential) users together at an early stage of developing a technology may smooth its transition from the laboratory to society and the market, because the wishes and needs of the customers are included in the industrial design process.

It is no surprise, therefore, that many instruments of innovation policy and promotion try to strengthen linkages within and across stakeholder groups in a national innovation system. Some important examples from Germany have already been mentioned (BioRegio, InnoRegio). One of the oldest instruments of innovation policy in post-war Germany is the AiF, the German Federation of Industrial Research Associations *(Arbeitsgemeinschaft industrieller Forschungsvereinigungen „Otto von Guericke" e.V. – www.aif.de)*. Founded in 1954, the Federation's primary mission is to promote cooperation between companies, mainly SMEs, in specific research areas. It helps companies form consortia and networks in order to resolve common technical problems through R & D. Through the BMWi the German Government co-finances projects that the consortia of SMEs assign to independent R & D institutes. The experiences gained from more than half a century of working in this publicly supported and targeted field of networking should be made available to policy-makers in partner countries. Until now, this has not often happened. Here again, the deployment of expatriate consultants to advise ministries and agencies, and the organising of short and long-term exposure trips to Germany are recommendable approaches.

Many activities related to building links between peers and across stakeholder groups within the innovation system are carried out by local and regional authorities and/or local and regional chambers of industry and commerce, often supported by German development cooperation actors (see the example of SEDA in Egypt, Box 12). Partnership programmes, such as those offered by the development organisation sequa, are an important tool for transferring specific knowledge to local and regional business organisations in partner countries. Sequa's programmes establish links between chambers of commerce and employers' organisations in Germany and developing countries, in order to strengthen the latter. They are providing relevant information about programmes and experiences in Germany, and supporting their partners with capacity building programmes.

When it comes to strengthening Eco-Innovation capacities in partner countries, an important approach is to link the research done at universities and public research institutes with the private sector. Companies are usually reluctant to approach research organisations when they want to develop new products or improve their processes, for example to make them more energy-efficient and less polluting. This is not something limited to developing countries, but is a general phenomenon observable in different countries. The reasons for this reluctance include the fear already mentioned of losing key knowledge, but there is also a lack of belief that external actors can really provide useful knowledge (the 'not-invented-here' syndrome). Building on existing experience in development cooperation in linking companies (especially SMEs) with external providers of knowledge and services – business development services (BDS) – a possible approach is to support partners in developing BDS markets around Eco-Innovations, offering services such as:

1. Identifying and mapping local, national and international/regional providers of Eco-Innovation-related services, and ensuring the supply side is transparent, for instance through:

- testing and certification of compliance with environmental standards, including management standards (e.g. HACCP)
- business consultancy in Eco-Innovation-related fields (organic farming, ISO 14000)
- developing process technologies that enhance the environmental performance of companies
- R & D for eco-product innovations.

2. Assisting national authorities in the accreditation of reliable and high-quality service providers.

3. Setting-up financing schemes such as voucher-systems specifically designed for Eco-Innovation-related BDS. The logic of vouchers for BDS is that companies (especially SMEs) can receive subsidies for their first interactions with service providers. As BDS can be categorised as experience goods, SMEs might not dare or wish to pay the full price for a service before they know the related costs will be compensated, at least in part, by enhanced competitiveness or increased sales and/or profits. So an initial subsidy may serve to generate a market for business services at a later stage. As Eco-Innovations suffer from specific market failures, the level of subsidies for Eco-Innovation-related BDS might have to be higher, and their reduction slower, than for more conventional BDS.

As few universities and research organisations are making research outputs available to existing or nascent companies, another important approach is to provide targeted advice for setting up patent offices at universities and research centres, and for promoting patenting among the researchers.

BOX 12

Multistakeholder partnership to promote solar water heating – the case of the Solar Energy Development Association (SEDA) in Egypt

The SEDA was founded as part of the Egyptian German Private Sector Development Programme (PSDP). SEDA's main mission is to promote the use of solar energy for heating water, for both domestic and commercial applications. Solar water heating can be seen as an important lever to increase the energy efficiency of buildings. While the basic technology is already quite mature, the innovative character comes from the need to adapt basic solutions to the various climatic and ecological conditions in different world regions.

SEDA is a multistakeholder platform, which brings together manufactures, importers, resellers, installers, customers, entrepreneurs, construction contractors and government entities. SEDA connects suppliers of solar water heaters (SWHs) with (potential) customers, helping the latter to identify the most appropriate solutions for specific situations. SEDA is promoting the quality certification of solar water heaters and is also addressing issues of technical qualification (installers and after-sales services). The association is also lobbying the Egyptian Government to instigate a ten-year national campaign for the widespread application of solar water heaters.

For more details see: http://seda-eg.com

To complement this, policy advice could focus on the establishment of national registers for intellectual property rights to ensure (national and international) transparency regarding the available knowledge and technologies related to Eco-Innovations. Furthermore, a national focal point for Eco-Innovation could ensure that local actors have access to knowledge related to the internationally available Eco-Innovations. This would concentrate on the knowledge and innovations that are in the public domain with open access.

4.4 Improving the underlying conditions

Crucial for supporting Eco-Innovation in developing countries is the overall strengthening of governance capacities in this complex policy field, which is also a new field for most developing countries. This includes the introduction of adequate monitoring and evaluation tools, and viable ways of swiftly readjusting policies if expected outcomes are not achieved, or if unexpected negative consequences are observed (see the introduction to Chapter 4 of this paper). It is especially important to consider that Eco-Innovation policies will only be effective if they include clear and stable market signals to the actors, since the amortisation period is often longer than it is in other investment projects.

Eco-Innovations can be boosted in developing countries through effective means of internalising the environmental costs, or by introducing much stricter environmental protection laws. In numerous countries, many such regulations have been put in place over the last two or three decades. These are often more closely related to efforts to protect local or regional, rather than global goods, for instance in the fields such as (industrial and agribusiness) sewage treatment and disposal, the reduction of urban air pollution etc. In many cases, enforcement is still an issue. In fact, any carrot-and-stick strategy to improve the environment should be seen as an opportunity for local businesses to develop new products and processing technologies using Eco-Innovations – either working alone or in alliances with international partners – and they should be communicated as such.

How we will deal effectively with climate change as the 'biggest market failure ever' *(Nicholas Stern)* is still to be seen. One important measure would be the implementation of environmental fiscal reforms, including the gradual elimination of subsidies for fossil fuels. The financial resources that would become available for other, more sustainable programmes would be very significant. However, reductions of fossil fuel subsidies are extremely contentious. Their broad implementation is very likely to be a significant source of social unrest, and they will need carefully designed programmes that compensate the poorer sections of society that would suffer most.

Carbon pricing is often seen as the best model for mobilising market forces through incentives for the transition from a fossil fuel-based energy system to one based on carbon-neutral sources. However, even in Europe, the problems involved in designing and implementing the relevant policies and instruments do not send promising signals about the implementation of a global carbon trading system in the near future.

Among the most important, yet also difficult topics in terms of a conducive environment for Eco-Innovations at the macro-level is the issue of protecting intellectual property rights. On the one hand, a reasonable level of protection is essential if local actors are to invest in R & D, or if foreign actors are to transfer technologies to developing countries, because only then can they expect to recover their innovation-related investments and achieve an adequate profit. On the other hand, a high degree of enforced protection may hamper the swift take-up of new knowledge and thus block the urgently needed impact for the protection of the environment. Public authorities can act to reconcile, at least in part, the conflicting interests of Eco-Innovation generation and their fast diffusion. Internationally, a number of mechanisms have been discussed and partially implemented, although this has so far mainly occurred in the context of global health technologies, and less in the field of Eco-Innovation. Examples include advance market commitments, patent pools, patent buyouts and patent commons *(see Carraz 2012, p. 184)*.

Open innovation can be considered the most far-reaching approach to the sharing of knowledge (see Box 13). Open source describes the idea of free distribution of, and access to knowledge about a new product, while open innovation refers to the collaboration of various parties (manufacturers, suppliers, customers etc.) in the process of creating or modifying new goods and services. Those collaborating can benefit from one another's knowledge of the technologies, as well as their needs, and they do not have to rely on their own limited knowledge and technologies.

BOX 13

Promoting collaborative innovation in Africa: Commons@IP

As part of GIZ's capacity building programme Train for Trade, commons@ip focuses on the interaction of intellectual property rights and open innovation, the knowledge commons, open licences and collaborative innovation in Africa. It supports capacity building and networking activities in the following areas:

- Equipping the private and public sectors in southern Africa with an important understanding of how the knowledge commons can be harnessed for open innovation;
- Fostering a more enabling legal environment for open innovation across the region, and mapping trade policy impacts on knowledge for innovation;
- Collaboration for open innovation and international exchanges between private sector actors.

Sources: Arbeitskreis Innovationssystemförderung (2011), https://gc21.giz.de

Unless their policies are embedded in an international agreement and aligned with the harmonised actions of many countries, governments in developing countries have only limited scope to address the complex intellectual property issues related to the dissemination of innovations, yet they can take the initiative to discuss these issues for instance in regional associations or at the global level.

BOX 14

An effective quality infrastructure for Eco-Innovation-based companies: the activities of the Physikalisch-technische Bundesanstalt (PTB, the German metrology institute)

The International Technical Cooperation section of the PTB advises on, and supports the conceptual design and practical implementation of quality infrastructure in developing and transition countries. Most PTB programmes are not sector-focused, but assist their partner countries in developing a coherent system of measurement (metrology), standardisation, testing, accreditation and certification. In this way, PTB contributes to the development of a conducive framework for Eco-Innovation.

There are direct links between the promotion of a national quality infrastructure and Eco-Innovation. For instance, monitoring climate change models requires highly developed technology and measuring techniques. The trustworthiness of scientific recommendations depends on the precision and validation of these measurements. For effective environmental protection (and the development of related Eco-Innovations) the environmental risks must be recognised, regulated and monitored. Substances need to be analysed for their environmental and health impacts, and production processes, products and services have to be tested to ensure their compliance with environmental directives and standards. Finally, processes and behavioural changes within the private sector and civil society, which affect the environment also have to be implemented.

Source: www.ptb.de/de/org/q/q5/docs/broschueren/PTB_BRO_Umwelt_en.pdf

Other options for improving the framework conditions for Eco-Innovation include:

- Designing adequate policies for the demand-side promotion of Eco-Innovations, such as feed-in-tariffs for renewable energies;
- Establishing an adequate system of quality assurance in order to measure and monitor the environmental performance of companies (see Box 14);
- Promoting consumer protection, e.g. following the German model of the Federation of German Consumer Organisations (Verbraucherschutzzentralen, vzbv), because effective complaint mechanisms for consumers are necessary if sufficient pressure is to be placed on producers to improve the quality of their products and services;
- Setting up adequate instruments for consumer information, possibly following the model of the Germany's Stiftung Warentest or the magazine Öko-Test, as consumers can only make educated buying decisions if they are well informed about the environmental aspects of different goods.

To promote Eco-Innovations on both the supply side and the demand side, coordination between the various ministries involved is often crucial. In many countries, the environment ministry is the one mainly responsible for protecting the environment as a public good, while others (agriculture, economy, forestry, mines and energy) are charged with organising the rational exploitation of natural resources for purposes of economic growth, employment and therefore also as a contribution to poverty reduction. Bringing together the various lines of policy and committing them to a common – or at least coordinated – programme would appear to be one of the biggest challenges yet an important contribution to sound policy-making for Eco-Innovation at the macro level. As this challenge is widespread, in developing as in developed countries, capacity building in this regard should be conceived as a mutual learning process.

Jatropha plant, often used in the production of biodiesel, India

Literature

Altenburg, T. / H. Schmitz / A. Stamm (2008): Breakthrough? China's and India's transition from production to innovation. In: World Development 36 (2), p. 325 – 344.

Arbeitskreis Innovationssystemförderung (2011): Innovationssystemförderung durch die deutsche EZ – Einige Beispiele.

Ashton, W. / A. Luque / J. R. Ehrenfeld (2002): Best practices in cleaner production promotion and implementation for smaller enterprises. Multilateral Investment Fund (MIF) and Inter-American Development Bank (IADB), Washington.

Atkinson, A. (2004): Appropriate Technologies in a Globalising World? Institute of Urban and Regional Planning, Technical University Berlin. http://cooperation.epfl.ch/webdav/site/cooperation/shared/events/Atkinson_text.pdf

Bauer, S. (2009): The ozone secretariat: the good shepherd of ozone politics. In: Biermann, F. / B. Siebenhüner (eds.): Managers of global change: The influence of international environmental bureaucracies. Cambridge.

Brandi, C. (2012): Low Carbon Standards and Labels in Rising Powers, University of Manchester, Rising Powers and Global Standards, Working Paper No. 5, Manchester.

Carraz, R. (2012): Improving science, technology and innovation governance to meet global challenges.In: OECD: Meeting Global Challenges through better governance. OECD Publishing, Paris.

Cole, M. A. / R. J. R. Elliott (2003): Do environmental regulations influence trade patterns? Testing old and new trade theories. In: The World Economy (26), 8, p. 1163 – 1186.

Dohse, D. (2005): Clusterorientierte Technologiepolitik in Deutschland: Konzepte und Erfahrungen. www.itas.fzk.de/tatup/051/dohs05a.pdf

Dörry, S. / A. Stamm (2009): Leistungsfähige Unternehmen des Südens als Partner der deutschen EZ? Unpublished document, GIZ, Berlin.

DST (Department of Science and Technology, 2007): South Africa's technology needs assessment for climate change. Pretoria.

Dutz, M. / S. Sharma (2012): Green Growth, Technology and Innovation. World Bank Policy Research Paper 5932. Washington.

Egeln, J. (2010): Unternehmensgründungen in Deutschland – EXIST: Bisher keine messbaren Effekte auf die Anzahl der Unternehmensgründungen. In: ZEW Gründungsreport: Aktuelle Forschungsergebnisse und Berichte zu Unternehmensgründungen, 10 (1).

Fichter, K. / T. Noack / S. Beucker / W. Bierter / S. Springer (2006): Nachhaltigkeitskonzepte für Innovationsprozesse. Nova-Net Werkstattreihe Innovationen in der Internetökonomie. FhG-IAO, Stuttgart.

Galbraith, K. (2008): Power From the Restless Sea Stirs the Imagination, New York Times, 22 August 2008.

GIZ (Gesellschaft für Internationale Zusammenarbeit, 2011a): Fast growth and big impact: How emerging market multinationals are advancing sustainable development. GIZ on behalf of BMZ (German Federal Ministry for Economic Cooperation and Development), Eschborn.

Guarin, A. / P. Knorringa (2012): New Middle Class Consumers in Rising Powers: Responsible Consumption and Private Standards. Working Paper: http://ssrn.com/abstract=2198971 or http://dx.doi.org/10.2139/ssrn.2198971

ICTSD (International Centre for Trade and Sustainable Development, 2012): Technology Transfer and Innovation: Key Country Priorities for Rio+20, accessed 15 August 2012.

Jonas, H. (1985): The imperative of responsibility: In search of an ethics for the technological age. Translation of "Das Prinzip Verantwortung", 1979. University of Chicago Press.

Kulicke, M. / T. Stahlecker / V. Lo / B. Wolf (2006): EXIST – Existenzgründungen aus Hochschulen – Bericht der wissenschaftlichen Begleitung zum Förderzeitraum 1998 bis 2005. BMWi, Berlin.

Lundvall, B.-A. (1985): Product Innovation and User-Producer Interaction. Industrial Development Research Series No. 31. Aalborg University Press.

Mansfield, E. (1985): How rapidly does new technological knowledge leak out? In: The Journal of Industrial Economics, 34 (2), p. 217 – 223.

Meyer, B. / M. Meyer / M. Distelkamp (2012): Modeling green growth and resource efficiency: new results. In: Mineral Economy 24, p. 145 – 154.

OECD (2002): Indicators to measure decoupling of environmental pressure from economic growth. Paris. online: www.oecd.org/dataoecd/0/52/1933638.pdf

OECD (2006): The measurement of scientific and technological activities. Proposed guidelines for collecting and interpreting technological innovation data. Oslo Manual. European Commission / Eurostat.

OECD (2010a): Climate Policy and Technological Innovation and Transfer. An Overview of Trends and Recent Empirical Results. OECD Studies on Environmental Innovation No. 30. Paris.

OECD (2010b): Eco-Innovation in Industry: Enabling Green Growth. OECD, Paris.

OECD (2010c): The OECD Innovation Strategy: Getting a Head Start on Tomorrow. OECD, Paris.

OECD (2011a): Better Policies to Support Eco-innovation. OECD Studies on Environmental Innovation. OECD, Paris.

OECD (2011b): Fostering Innovation for Green Growth. OECD, Paris.

OECD (2011c): Invention and Transfer of Environmental Technologies. OECD Studies on Environmental Innovation. OECD, Paris.

OECD (2011d): Demand-side Innovation Policies. OECD, Paris.

OECD (2011e): Towards Green Growth, OECD, Paris.

OECD (2012): The jobs potential of a shift towards a low-carbon economy. Final report for the European Commission, DG Employment. OECD, Paris.

Ömer-Rieder, B. / T. Tötzer (2004): Umweltinnovation als spezieller Innovationstyp. ARGE Innovationsorientierte nachhaltige Regionalentwicklung. Report ARC – sys/ZIT-0001.

O'Sullivan, M. / D. Edler / Th. Nieder / Th. Rüther / U. Lehr / F. Peter (2012): Bruttobeschäftigung durch erneuerbare Energien in Deutschland im Jahr 2011 – eine erste Abschätzung – Stand: 14. März 2012. http://tinyurl.com/bcgr4fu

Plechero, M. / C. Chaminade (2010): From new to the firm to new to the world. Effect of geographical proximity and technological capabilities on the degree of novelty in emerging economies, University of Lund, Circle Paper No. 2010/12. Lund. www.circle.lu.se/upload/CIRCLE/workingpapers/201012_Plechero_Chaminade.pdf

Royal Society (2011): Knowledge, networks and nations – Global scientific collaboration in the 21st century. London.

Schumacher, E. F. (1977): Die Rückkehr zum menschlichen Maß: Alternativen für Wirtschaft und Technik. Small is Beautiful. Rowohlt, Reinbek bei Hamburg.

Skjærseth, J. B. / J. Wettestad (2008): Implementing EU emissions trading: success or failure? In: International Environmental Agreements: Politics, Law and Economics, 8 (3), p. 275 – 290.

Smith, K. (2009): Climate Change and Radical Energy Innovation: The Policy Issues. TIK Working Papers on Innovation Studies, No. 20090101. Oslo.

Sorrell, S. / J. Dimitropoulos (2008): The rebound effect: microeconomic definitions, limitations and extensions, Ecological Economics 65 (3), p. 636 – 649.

Stamm, A. / E. Dantas / D. Fischer / S. Ganguly / B. Rennkamp (2009): Sustainability Oriented Innovations Systems: Towards Decoupling Economic Growth from Environmental Pressures? DIE Discussion Paper 20/2009. GDI/DIE (German Development Insitute), Bonn.

Stamm, A. (2008): Agribusiness and poverty reduction: what can be learned from the value chain approach? In: Christina Stringer / Richard Le Heron (eds.), Agrifood commodity chains and globalising networks; the dynamics of economic space, Aldershot, Ashgate, p. 23 – 34.

Stephan, C. / A. Stamm (2010): Faire Wertschöpfungsketten: sozialverträgliche Formen der Modernisierung in Sri Lankas Zimtsektor. In: Karin Fischer / Christian Reiner / Cornelia Staritz (Hrsg.), Globale Güterketten: weltweite Arbeitsteilung und ungleiche Entwicklung, Wien, Promedia, p. 139 – 156.

UN (2012): The Future we want. Draft Resolution. General Assembly, Sixty-sixth session, Agenda item 19, Sustainable development. New York. www.un.org/en/ga/president/66/Letters/PDF/Rio+20%20Draft%20Resolution-24%20July.pdf

UNDP / UNFCCC (2010): Handbook for conducting technology needs assessments for climate change. New York.

UNEP (2008): Green Jobs: Towards Decent Work in a Sustainable, Low-Carbon World. Nairobi.

UNEP (2009): Global Green New Deal. Policy Brief. United Nations Environment Programme. Geneva. www.unep.org/pdf/A_Global_Green_New_Deal_Policy_Brief.pdf

Vidican, G. (2012): Building domestic capabilities in renewable energy: a case study of Egypt. GDI/DIE (German Development Institute) Studies 66. Bonn.

World Bank (2012): Inclusive green growth: The pathway to sustainability. Washington.

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